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Science Bulletin

MITES OF UTAH MAMMALS

by

DORALD M. ALLRED AND D ELDEN BECK

BIOLOGICAL SERIES — VOLUME VIII, NUMBER 1

OCTOBER, 1966

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MITES OF UTAH MAMMALS

by

Dorald M. Allred and D Elden Beck*

INTRODUCTION

In 1949 a systematic survey was initiated by the junior author to determine the ecological relationships of parasitic arthropods associated with reptiles, birds, and mammals in Utah. Emphasis was given to the rodents rather than the larger mammals, birds, reptiles, and nests which were collected less frequently. Approximately 9,000 small mammals were examined for ectoparasites between April, 1949, and August, 1965 (Table 1). Financial support was obtained from the National Institutes of Health (Grants E-102, E-1273, A1-01273, and A1-01273-08) and from Brigham Young University primarily to study fleas and ticks, but lice and mites also were collected. The records of the mites taken during the sixteen-year period constitute the basis of this report.

Financial support specifically for analysis and publication of the data on mites was received from the National Institutes of Health (Grants GM 12321-01 and GM 12321-02). Release time was allowed the senior author by Brigham Young University as a Faculty Research Fellow (1965-66) to pursue work on this project. Other financial support and facilities furnished by Brigham Young University in past years contributed considerably toward our objectives. We appreciate the kindness of Dr. Russell W. Strandtmann, Texas Technological College; Dr. Frank J. Radovsky, George Williams Hooper Foundation; Dr. James M. Brennan, Rocky Mountain Laboratory; Dr. Richard B. Loomis, California State College at Long Beach; and Dr. Clive D. Jorgensen, Brigham Young University, for identification and/or verification of identification of some of the mites, for suggestions pertaining to some of the taxonomic problems, and for critical review of the manuscript. Many technicians assisted in mounting the mites over several years, but we are especially grateful to Mr. Selby Herrin, graduate student at Brigham Young University, for most of the mounting as well as pencil drawings of the mesostigmatids. Mr. Morris Goates, Skyline High School, Salt Lake City, identified and made pencil drawings of the chiggers. We are grateful to the many students and faculty of the Department of Zoology and Entomology and others who collected mites over the past 16 years.

Topographical and Faunal Features

Utah encompasses the western part of the Upper Colorado River Basin and the eastern part of the Great Basin (Fig. 615). The diversified topography varies in elevation from 2,760 ft to 13,498 ft, and the biotic features vary from desert shrub to alpine areas. Consequently there is a great diversity of habitats and fauna within the state. For further descriptions of the biotic and faunal areas of these basins, refer to the excellent discussions by Durrant (1952), Beck (1955), and Hayward, Beck, and Tanner (1958).

TABLE 1. NUMBERS OF MAMMALS EXAMINED AND FOUND INFESTED WITH ECTOPARASITES IN UTAH BETWEEN 1949 AND 1965 (BRIGHAM YOUNG UNIVERSITY, DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, PROJECT 10).

Group and species*	No. examined	No. infested with: Fleas	Lice	Mites	Ticks
SHREWS					
Sorex sp.	2				
S. palustris	5			2	
S. vagrans	7	1		1	1
BATS					
Corynorhinus townsendii	16			12	
Myotis sp.	642	47	2	597	
M. californicus	3	1		2	
Pipistrellus sp.	3			2	2
Tadarida brasiliensis	2			1	1
PIKAS					
Ochotona princeps	95	75	1	80	43
RABBITS AND HARES					
Lepus sp.	1				1
L. americanus	4	2			2
L. californicus	561	50	4	18	454
L. townsendii	13	6		8	

*Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

Sylvilagus sp.	79	48		1	43
S. audubonii	60	33	6	13	41
S. idahoensis	16	11		4	11
S. nuttallii	20	16		2	17
SQUIRRELS AND RELATIVES					
Ammospermophilus leucurus	113	90	36	26	21
Cynomys sp.	3	2	2	3	2
C. gunnisoni	1	1			
C. leucurus	13	7	2	4	5
C. parvidens	3	3		1	2
Eutamias sp.	24	19	7	13	3
E. dorsalis	28	10	4	5	8
E. minimus	122	81	32	43	60
E. quadrivittatus	97	58	45	35	29
E. umbrinis	8	1	6		1
Glaucomys sabrinus	4	2	1	2	2
Marmota flaviventris	52	40	29	9	16
Sciurus aberti	1	1		1	1
Spermophilus armatus	254	170	132	98	116
S. beldingi	4	3			2
S. lateralis	130	76	18	54	82
S. richardsonii	7	7	4	1	4
S. spilosoma	2	2			1
S. townsendii	8	5	2	1	2
S. tridecemlineatus	5	2	3	1	1
S. variegatus	60	49	7	17	18
Tamiasciurus hudsonicus	56	33	11	14	8
POCKET GOPHERS					
Thomomys sp.	12	3	2	6	1
T. talpoides	151	64	54	37	19
T. umbrinus	73	30	47	29	2
HETEROMYIDS					
Dipodomys sp.	15		1	2	6
D. deserti	7	4	2	5	2
D. merriami	152	68	13	63	49
D. microps	87	6	11	48	32
D. ordii	820	293	222	610	351
Microdipodops megacephalus	6				6
Perognathus sp.	63	3	5	24	9
P. apache	12		1	10	
P. formosus	96	3	27	55	10
P. intermedius	1				
P. longimembris	72	1	2	14	30
P. parvus	224	46	19	82	86
BEAVERS					
Castor canadensis	4				
CRICETID RODENTS					
Neotoma sp.	9	6	1	4	4
N. albigula	3	2		1	1
N. cinerea	29	25	5	7	6
N. lepida	149	80	20	56	20
N. mexicana	1	1			
Onychomys sp.	9	7	2	3	
O. leucogaster	32	27	7	19	9
O. torridus	4	3	2	2	1
Peromyscus sp.	20	6	1	10	1
P. boylii	13	4	1	6	
P. crinitus	128	49	14	72	20
P. eremicus	198	85	45	102	12
P. maniculatus	3077	1821	723	1254	805
P. truei	184	63	33	103	23
Reithrodontomys megalotus	122	37	6	20	11
MICROTINE RODENTS					
Clethrionomys gapperi	27	7	10	15	5
Lagurus curtatus	1			1	
Microtus sp.	95	40	39	54	34
M. californicus	1	1			1
M. longicaudus	74	39	6	35	20
M. mexicanus	1	1			
M. montanus	59	32	44	52	16
M. pennsylvanicus	3		3	3	
Ondatra zibethicus	6	5		2	
Phenacomys intermedius	2	1	1	2	
MURID RODENTS					
Mus musculus	23		7	6	
Rattus norvegicus	151	25	98	73	6
R. rattus	9	4	2	3	
JUMPING MICE					
Zapus princeps	96	64	1	25	30
HYSTRICOMORPH RODENTS					
Erethizon dorsatum	36	1	1	22	
FOXES AND COYOTES					
Canis latrans	4	1			4
Urocyon cinereoargenteus	1				1
Vulpes macrotis	4	3			1
RACOONS AND ALLIES					
Bassariscus astutus	1	1			
Procyon lotor	1	1			
MUSTELIDS					
Martes sp.	1	1			1
Mephitis mephitis	1				1
Mustela erminea	1				
M. frenata	11	10	4	5	5
M. vison	2				2
Spilogale gracilis	11	7	2	2	8
Taxidea taxus	6		1		3
CATS					
Lynx rufus	6	3			2
CERVIDS					
Cervus canadensis	1				1
Dama hemionus	28		1		25
DOMESTIC ANIMALS					
Cat	4	2			2
Cow	3				1
Dog	16		4		9
Hog	1		1		2
Horse	7		1		6
Rabbit	2	1	2		
Sheep	2				

*Major groupings and names follow Hall and Kelson (1959) except for alphabetical arrangement of genera and species.

HISTORICAL REVIEW

Until recent years little was published on parasitic mites from Utah. Keegan (1949, 1953, 1956b) described a new species, erected a new genus based on Utah material, and listed a number of new records for the state. Allred and Beck (1953b) described a new species of chigger (which was later synonymized by Brennan and Beck, 1955), and studied mites of woodrat nests in Utah (1953a). Allred (1954a, 1954c, 1957b, 1957c, 1957d, 1958) studied mites found on mice of the genus *Peromyscus* in Utah, described a new species (1957a), discussed morphological variations and bionomics (1954b, 1957e, 1957f, 1957g, 1965), and listed additional host records (1961). Furman and Tipton (1955) named a new species from Utah and composed a key to the known species of *Myonyssus*. Brennan and Beck (1955)* listed host and distribution records, named new species, and included a key to the chiggers of Utah. Lipovsky, Crossley and Loomis (1955) also named a new genus and species of chigger from Utah. Woodbury (1956a, 1956b) composed a checklist of mites taken in ecological studies at Dugway and indicated host relationships. Strandtmann and Allred (1956) discussed mites of the genus *Brevisterna*, listed additional host and distribution records, and composed a key to the species. Howell, Allred and Beck (1957) studied mites found in woodrat nests and listed parasitic as well as free-living species. Allred and Marchette (1957) studied the feeding habits of *Brevisterna utahensis* in Utah. Talley (1957) studied the nasal mites of blackbirds. Allred and Roscoe (1957) studied parasitic mites in woodrat nests. Howell and Elzinga (1962) described a new species of fur mite and composed a key to the species of *Radfordia*. Elzinga (1960) listed mites of rodents from one specific area in Utah, and Ho (1962) listed mites from two areas. Ash (1963) studied the mites of deer mice in a chaparral community. Jenkins (1965) listed records of mites from squirrels taken in 12 counties.

Other workers have published data on mites from Utah principally as incidental records associated with studies of other areas or fauna. These are listed in the species discussions that follow.

MEDICAL AND ECONOMIC IMPORTANCE

Dermanyssus americanus and *D. gallinae* have been involved with encephalomyelitis, but their exact relationship with the virus is not entirely clear (Baker *et al.*, 1956). Transmission of trypanosomes and avian spirochaetosis has been demonstrated for *D. gallinae* (Macfie and Thompson, 1929; Manwell and Johnson, 1931; Seddon, 1951). Rickettsialpox transmission has been related to *D. sanguineus* (Huebner *et al.*, 1946). The implication of these species with disease suggests a similar potential for *D. becki* which also occurs in Utah.

Ornithonyssus bacoti has been involved with murine typhus, rickettsialpox, tularemia, plague and nematode parasites (Baker *et al.*, 1956). Transmission of encephalomyelitis and Newcastle disease has been related to *O. sylviarum* (Baker *et al.*, 1956).

Laelaps jettmari has been involved with hemorrhagic fever (Asanuma, 1952), and *L. kochi* has a suspected implication with tularemia (Baker, *et al.*, 1956). Nothing is known of the potential of other species of *Laelaps* which occur in Utah.

Tularemia has been isolated from *Eulaelaps stabularis* and *Haemolaelaps mohrae* (Baker, *et al.*, 1956). Other species of *Haemolaelaps*, including the cosmopolitan *H. glasgowi*, have not as yet been implicated with disease transmission. Ornithosis virus of turkeys has been isolated from *Haemolaelaps casalis*, *Haemogamasus pontiger*, and *Ornithonyssus sylviarum* (Eddie, *et al.*, 1962).

Hirstionyssus isabellinus has been implicated with tularemia in the laboratory (Francis and Lake, 1922).

In addition to their disease transmission potential, mites occasionally are pests of man by their bites or invasion of his tissues. *Dermanyssus*

*Although the printed date on this publication is 31 December 1955, it was not off the press and distributed until early 1956. Consequently, for purposes of priority this reference should be considered as 1956. However, to maintain continuity of publication dates, throughout this paper it is listed as 1955.

gallinae, *D. sanguineus*, *O. bacoti*, *O. bursa*, *O. sylviarum* and *H. casalis* have been known to attack man, and there is some circumstantial evidence to incriminate *E. stabularis* and *H. pontiger*. Still other parasitic mites may bite man on occasion.

The high populations of rodents in the temperate desert areas of Utah, and the presence of many mites which have been implicated with disease transmission as shown above, create a potential reservoir of diseases in nature communicable to man, which necessitates an increased knowledge of their natural history and other aspects of ecology.

ACCOUNTS OF THE SPECIES

In the discussion that follows, a brief statement is given about each family represented, usually followed by a listing of each species known to occur in Utah. However, several families are listed for which mites were not identified beyond the family level. These were occasionally found on mammals but are not considered regular consortes with them. Their inclusion is for convenience in separating them from mites which have more common occurrence and which for the most part are parasitic on their mammalian hosts.

Following the list of each species, comments on taxonomic or morphological variations are included when applicable. Under the heading "Distribution," published records for the United States are noted. In most cases only the earliest published record is given. Recently published literature which duplicates previous records is not indicated. Where more than ten hosts are known for a state other than Utah, only a general statment on host relationships is given. Names for host records were taken verbatim from literature references. In Table 3 the equivalent names listed by Hall and Kelson (1959) are indicated in parentheses. For more specific locality references, records for Utah are listed by county.

Following the heading "Other Utah Records" or "Utah Records," heretofore unpublished data are listed as represented by our surveys over the past sixteen years. For the most part the only records given are those which are new host or county records for Utah. In most instances where our collections duplicate previously listed records, we have not repeated them. Each of our records is represented by detailed collection data in our files, but it is not practical to list such details at this time. Information on these data may be obtained by request. "Seasonal Occurrence" is a summary of months over the total sixteen-year period. Under "Comments" when sufficient data are available, the geographic distribution in Utah (northerly or southerly) and occurrence in the Great Basin or Upper Colorado River Basin are indicated (Fig. 615). Apparent host preferences and other mite species associations are also listed.

Keys to families, genera and species are inserted where appropriate. Keys to the nymphs and males of some groups of Mesostigmata are lacking because of insufficient descriptions, or because these stages are unknown for many species. Key characteristics selected to separate the families, genera and species of mites known to occur on mammals in Utah are for the most part those which are most easily seen. These may not be valid when dealing with species not included here. A properly cleared and mounted specimen is a necessary prerequisite to its identification when dealing with the dorsal plate, chelicerae, legs, and specialized seta on the palpal tarsus. Such characters are best seen with a phase-contrast microscope. Where a specific feature is not visible or for the purpose of verification, structures other than those listed in the keys may be used, and drawings of these for most species or a representative of each genus or family are appended. Setae usually are not shown except on the ventral plates of the mesostigmatids and the scuta of the trombiculids. The keys to the males were composed using some specimens from areas other than Utah, and from literature descriptions. Relating the male or nymph to the female with which it is found is an aid to its identity, but discretion should be used. Where possible, verification should be made by comparing the specimen with one whose identity is known, and with the description of the type where such is adequate and available.

In the descriptions of new species, measurements given are in microns. For purposes of structural orientation and to avoid duplication, figure references in the keys relate to Figures 1 to 5 on pages 5 to 7, and other illustrations beginning on page 71.

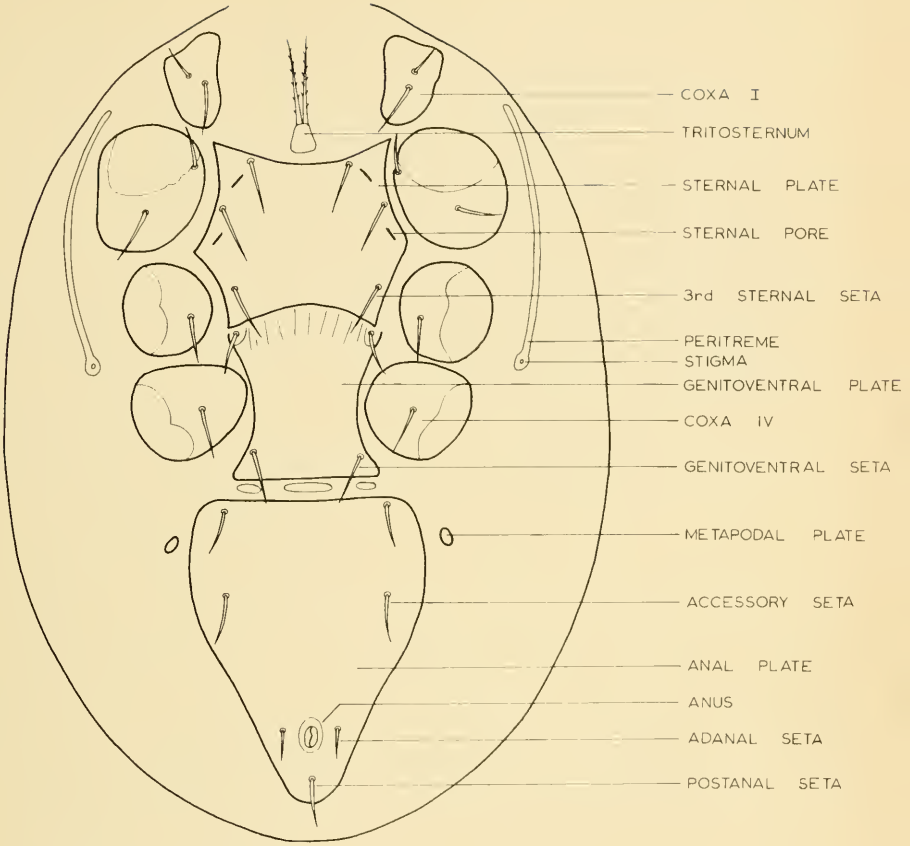


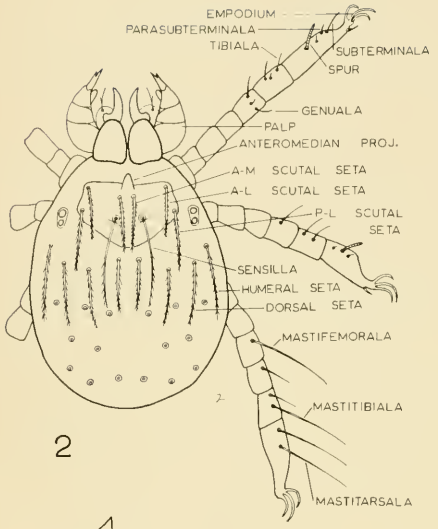
Fig. 1. Neoparasitidae, female ventral.

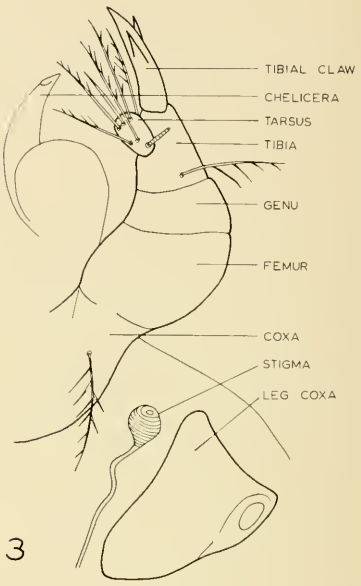
KEY TO FAMILIES OF FEMALE AND MALE MITES AND LARVAL TROMBICULIDS FOUND ON MAMMALS IN UTAH

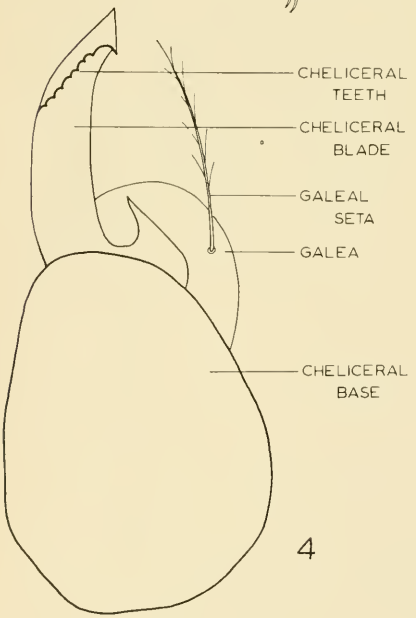
1. With a lateral stigma situated dorsal to and at level between coxae III and IV (Fig. 1) ... 2
   Without lateral stigma as above ... 12

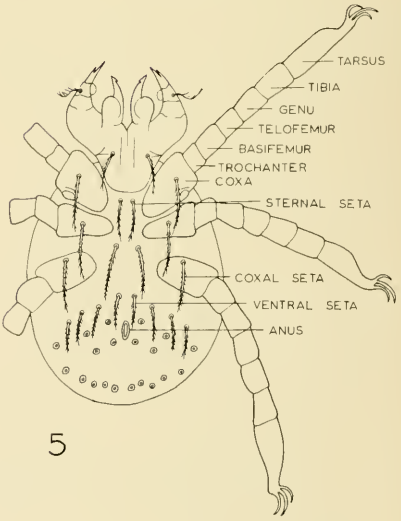
2. With tritosternum (Fig. 1); ventral and dorsal plates well-developed (Fig. 1) ... 4
   Without tritosternum; dorsal and ventral plates much reduced or absent (Fig. 8) ... 3

3. Coxae arranged essentially in two parallel lines, situated on anterior half of body (Fig. 7); poorly selerotized mites with few small setae ... Halarachnidae, page 9
   Coxae somewhat radially arranged, occupying anterior three-fourths of body (Fig. 8); heavily selerotized mites, densely covered with setae (from bats) ... Spinturnicidae, page 9









Figs. 2-5. Chigger larva. 2, body dorsal; 3, left half gnathosoma ventral; 4, right chelicera dorsal; 5, body ventral.

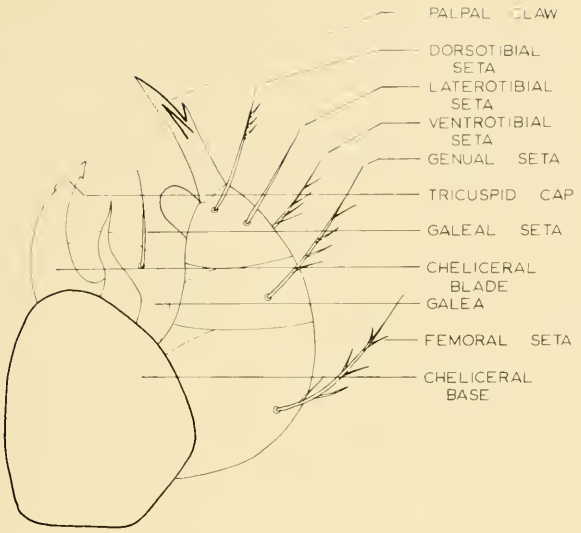


Fig. 6. Chigger larva, right half gnathosoma dorsal.

4. Specialized seta on palpal tarus with three tines (Fig. 407) ..... Complex of Gamasolaelaptidae, Macrochelidae, Neoparasitidae, Pachylaelaptidae, Parasitidae, pages 8-9

   Specialized seta with two tines 5

5. Anterior edge of sternal plate with circular structure and/or posteriorly extending tube, the genital opening (Fig. 353); ventral plates fused into one holoventral plate (Fig. 355) or sometimes two plates (sternogenital and ventroanal, Figs. 362, 171, or sterno-genitoventral and anal, Figs. 351, 170) (males in part) 10

   Anterior edge of sternal plate without such genital opening; ventral plates separate as three distinct plates (Fig. 1) (females, in part) 6

6. Genitoventral plate truncate posteriorly, usually almost touching enlarged anal plate which is frequently truncate anteriorly (Fig. 1) 7

   Genitoventral plate rounded or pointed, not truncate, widely separated from anal plate which may be truncate anteriorly but usually is elliptical or oval (Fig. 195) 8

7. Metapodal plate large, triangular (Fig. 410); genitoventral plate expanded laterally behind coxae IV (Fig. 220) ..... Haemogamasidae, page 10

   Not as above ..... Phytoseiidae (=Amblyseiidae and Blattisocidae, in part), page 15

8. Dorsal plate thickly beset with setae which overlap those following; genitoventral plate with four or more pairs of accessory setae (Fig. 220) ..... Haemogamasidae, page 10

   Dorsal plate setae relatively sparse, seldom overlapping those behind; genitoventral plate with less than four pairs of accessory setae (Fig. 258) 9

9. Chelicera moderate to small, sometimes long, styletlike, filamentous; chela lacks teeth, weakly sclerotized (Figs. 386, 389) ..... Dermanyssidae, page 16

   Chelicera strongly developed; chela large, with teeth, heavily sclerotized (Fig. 383) ..... Laelaptidae, page 33

10. Body densely clothed with setae which frequently extend past bases of those behind; holoventral plate usually widely expanded laterally behind coxae IV (Fig. 354) ..... Haemogamasidae, page 10

    Not as above 11

11. Chelicera small, hyaline, weakly scherotized, sometimes long, styletlike (Fig. 389) ..... Dermanyssidae, page 16

    Chelicera strongly developed, heavily sclerotized (Fig. 383) ..... Laelaptidae, page 33

12. Palp relatively large, conspicuous (Fig. 2); chelicera modified as piercing stylet (Fig. 4), sometimes when long and needle-like, frequently recurved when withdrawn within body (Fig. 389) 13

    Palp small, inconspicuous; chelicera strongly chelate, although it may be small; body elongate, rounded or bilobed posteriorly (Fig. 599) ..... Listrophoridae, page 41

13. First pair of legs greatly modified for clasping hairs (Fig. 596) ..... Myobiidae, page 42

    First pair of legs not as above 14

14. With three pairs of legs; scutal plate provided with pair of flagelliform or expanded sensillae (Fig. 2); tarsus II lacks multiple empodium (Fig. 2) ..... Trombiculidae, page 42

    With four pairs of legs; lacks scutal plate; tarsus II with multiple empodium (Fig. 598) ..... complex of Tetranychidae and Cheyletidae, page 56

PACHYLAELAPTIDAE Vitzthum, 1931

Fig. 7

Mites of this family occur in accumulations of organic debris, and frequently on beetles. They likely are predaceous. Their occurrence on mammals in our studies was infrequent.

GAMASOLAELAPTIDAE Oudemans, 1939

Fig. 194

Mites of this family occur in mesic situations where they likely are predaceous on other small arthropods. Their occurrence on mammals in our studies likely was accidental.

NEOPARASITIDAE Oudemans, 1939

Fig. 1

Mites of this family are similar in habits and occurrence to those in the family Gamasolaelaptidae. They were infrequently found on mammals in our surveys.

Halarachinidae Oudemans, 1906

Mites of this family are endoparasitic in the nasal passages of mammals, both marine and terrestrial. Their recovery is dependent on special techniques which are not usually utilized in routine ectoparasite field surveys.

Zumptiella bakeri Furman, 1954

Figs. 46, 120, 200, 209

Distribution. CALIFORNIA: *Tamiasciurus douglasii* (Furman, 1954a).

Utah records. Sevier Co.: *Eutamias quadrivittatus.* Utah Co.: *Citellus armatus.*

Seasonal occurence. Two females were taken in July.

Spinturnicidae Oudemans, 1901

These mites occur almost exclusively on bats, and likely are world-wide in distribution.

KEY TO GENERA OF SPINTURNICIDAE

Peritreme on dorsal surface only (Fig. 594) ..... *Paraspinturnix*
Peritreme extends to ventral surface of body (Fig. 59) ..... *Spinturnix*

Paraspinturnix globosus Rudnick, 1960

Figs. 8, 148, 281, 325, 594

Distribution. ARIZONA: Bat; INDIANA: *Myotis sodalis;* OKLAHOMA: *Myotis grisescens, Myotis velifer;* TENNESSEE: *M. sodalis;* UTAH: Utah Co.: *Myotis* sp. (Rudnick, 1960).

Other Utah records. None.

Spinturnix orri Rudnick, 1960

Figs. 11, 59, 147, 283, 324

Distribution. CALIFORNIA, OREGON, TEXAS: *Antrozous pallidus;* UTAH: Millard Co., Salt Lake Co., Wayne Co.: *A. pallidus* (Rudnick, 1960).

Other Utah records. None.

Parasitidae Oudemans, 1901

Fig. 192

Mites of this family are predaceous on other small arthropods usually associated with moist organic debris. They were infrequently found on mammals in our surveys.

Macrochelidae Vitzthum, 1930

These mites are commonly found in soil and on animals. They likely are predaceous and are frequently found on mammals, although unlikely in a parasitic association.

Macrocheles sp.

Figs. 113, 199, 223, 407, 551

Distribution. COLORADO: *Thomomys talpoides* (Miller and Ward, 1960). OKLAHOMA: *Sigmodon* sp. (Ellis, 1960). TEXAS: *Citellus spilosoma, Rattus norvegicus, Speotyto cunicularia* (Eads, Menzies, and Miles, 1952). UTAH: Utah Co.: *Reithrodontomys megalotis* (Elzinga, 1960). ? locality: *Citellus armatus* (Jenkins, 1965).

Other Utah records. Cache Co.: *C. armatus, T. talpoides.* Juab Co.: *Dipodomys ordii, Peromyscus maniculatus.* Kane Co.: *Perognathus longimembris, Thomomys bottae.* Utah Co.: *C. armatus, Marmota flaviventris, Mus musculus, Zapus princeps.* Wasatch Co.: *C. armatus.* Washington Co.: *Onychomys torridus.*

Seasonal occurrence. A total of 115 females was collected during February, April, May, June, July, and December. Most were taken in June.

Comments. Mites of this species were most common in the northern part of Utah in the Great Basin. They are known from six counties.

In three of 25 collections, *Macrocheles* sp. was the only mite on its host.

HAEMOGAMASIDAE Oudemans, 1926

Mites of this family are world-wide parasites of small mammals. Most of their lives are spent in the nests of their hosts except for times of feeding.

KEY TO GENERA OF FEMALE HAEMOGAMASIDAE

1. Sternal plate short, about one-half as long as wide, possesses only first or second pair of usual sternal setae (Figs. 201, 205); one or two pairs of accessory setae may be present ..... *Brevisterna*

   Sternal plate length more than one-half its width, with usual three pairs of sternal setae (Fig. 199) 2

2. Anal plate wider than long (Fig. 121); metapodal plate large, triangular (Fig. 410) ..... *Eulaelaps*, page 11

   Anal plate as long as or longer than wide (Fig. 110); metapodal plate small, usually oval 3

3. Tarsus II with large spines (Fig. 601) ..... *Ischyropoda*, page 11
   Tarsus II similar to other legs ..... *Haemogamasus*, page 12

KEY TO GENERA OF MALE HAEMOGAMASIDAE

1. Ventral plates fused into one holoventral plate (Fig. 359) 2

   Two ventral plates, anal plate separate (Fig. 351) ..... *Ischyropoda*, page 11

2. Holoventral plate greatly expanded, extends laterally behind coxa IV (Fig. 352) 3

   Holoventral plate only slightly expanded, does not extend behind coxa IV (Fig. 359) ..... *Brevisterna*

3. Holoventral plate strongly reticulate posteriorly; has five pairs of nude setae between posterior level of coxa IV and anterior edge of plate ..... *Eulaelaps*, page 11

   Holoventral plate not reticulate posteriorly; has five or more pairs of setae between posterior level of coxa IV and anterior edge of plate (when only five pairs present, anterior pair barbed) ..... *Haemogamasus*, page 12

KEY TO SPECIES OF FEMALE *Brevisterna*

Sternal plate with only the usual first pair of setae; one or two pairs of accessory setae may be present (Fig. 201) ..... *montanus*

Sternal plate with only the usual second pair of setae; no accessory setae (Fig. 205) ..... *utahensis*, page 11

Brevisterna montanus (Ewing), 1922

Figs. 43, 118, 201, 231, 546

Strandtmann and Allred (1956) stated that of three specimens on the type slide, two have two accessory setae and one has four. The genitoventral plate bears about 14 setae, and the dorsal plate covers most of the body. Three of the Utah specimens have two accessory setae, one has only one, and two lack accessory setae on the sternal plate. Two specimens possess 16 setae on the genitoventral plate, and the other four possess 14, 15, 18 and 19, respectively. The setae

are frequently not symmetrically arranged on the genitoventral plate except for the anterior two pairs, and the plate has irregular, unsymmetrical borders in most cases. The dorsal plate covers about one-half to two-thirds of the dorsal surface.

Distribution. MONTANA: *Sciurus hudsonicus* (Strandtmann and Wharton, 1958).

Utah records. Two females were taken from *Eutamias quadrivittatus* from Utah County in June, and four females from the same host from Daggett County in August.

Brevisterna utahensis (Ewing), 1933

Figs. 44, 73, 78, 109, 182, 205, 216, 330, 359, 548

Strandtmann and Allred (1956) and Allred (1957b, 1957g) discussed morphological variations of this species. The specimens in our study are within the ranges indicated by them.

Distribution. ARIZONA. CALIFORNIA: *Neotoma* sp. (Keegan, 1953). NEVADA: *Neotoma lepida, Peromyscus crinitus* (Allred and Goates, 1964a, 1964b). TEXAS: *Neotoma micropus* (Eads, Menzies, and Miles, 1952). UTAH: Carbon Co.: *Peromyscus maniculatus* (Allred, 1957b). Juab Co.: *N. lepida* (Howell, Allred, and Beck, 1957). Sevier Co.: *N. lepida* (Ewing, 1933). Tooele Co.: *N. lepida, Onychomys leucogaster* (Keegan, 1953), *P. crinitus* (Woodbury, 1956b). Utah Co.: *O. leucogaster* (Elzinga, 1960). Wayne Co.: *P. crinitus;* Washington Co.: *P. eremicus* (Allred, 1957b).

Other Utah records. Daggett Co.: *Eutamias quadrivittatus, Neotoma cinerea.* Duchesne Co.: *N. cinerea.* Emery Co.: *P. crinitus, Peromyscus truei.* Grand Co.: *N. lepida.* Kane Co.: *N. lepida, P. maniculatus, P. truei.* Piute Co.: *N. lepida.* San Juan Co.:*Peromyscus boylii, P. maniculatus, P. truei.* Sanpete Co.: *P. maniculatus.* Utah Co.: *Citellus variegatus, E. quadrivittatus, Mus musculus, N. cinerea, N. lepida, P. maniculatus.* Washington Co.:*Dipodomys merriami, Lepus californicus, N. lepida, Perognathus formosus.* Wayne Co.: *N. lepida, P. maniculatus, P. truei.*

Seasonal occurrence. Totals of 39 deutonymphs, 23 males and 114 females were taken. Mites were collected every month except January, March, and December. The high incidence of gravid females taken in April, May and June (50%, 42% and 23%, respectively) is indicative of a spring reproductive period. This is further supported by the high incidence of deutonymphs taken in July (78% of the total mites collected for that month). Males were not abundant and were taken only during April, May, June, November, and December.

Comments. Mites of *B. utahensis* are more common in the southern than in the northern part of Utah, and more typical of the upper Colorado River Basin than of the Great Basin. In the Great Basin collections, with only three exceptions, they were found close to the high mountains that divide the two basins.

This mite apparently is most closely associated with wood rats (*Neotoma* spp.). Two-thirds of the other incidental collections were taken from rodents which live in close association with wood rats and their habitat. Fifty percent of the collections were from *Neotoma* spp., and 44% of these were from *N. lepida.* Association with *N. lepida* suggests a southern distribution, whereas the occurrence of *B. utahensis* on *N. cinerea* may account for its more northerly occurrence.

In 19 of the 43 collections, *B. utahensis* was the only mite species found on its host.

Eulaelaps stabularis (Koch), 1836

Figs. 121, 203, 246, 410, 553

Distribution. ALABAMA: *Blarina brevicauda, Peromyscus gossypinus, Peromyscus nuttallii, Reithrodontomys humilis, Sigmodon* sp. (Hays and Guyton, 1958). CALIFORNIA: *B. brevicauda* (Jameson, 1950d). COLORADO: *Thomomys talpoides* (Miller and Ward, 1960). MARYLAND: *Microtus pennsylvanicus* (Drummond, 1957). NEW YORK: *Napeozapus insignis* (Whitaker, 1963). OREGON: *Microtus montanus, Peromyscus maniculatus* (Hansen, 1964). TEXAS: *Didelphis* sp., *Geomys* sp., *Rattus rattus* (Randolph and Eads, 1946).

Utah records. Daggett Co.: *Microtus* sp. Sanpete Co.: *P. maniculatus.* Utah Co.: *Citellus armatus, P. maniculatus, Rattus norvegicus.*

Seasonal occurence. Seven females were taken in February, May, June and August.

Comments. The records by Allred (1954a) of *Eulaelaps* sp. from *P. maniculatus* from Iron, Salt Lake, Sanpete and Utah counties likely are of *E. stabularis.*

KEY TO SPECIES OF FEMALE *Ischyropoda*

Dorsal plate truncate posteriorly (Fig. 47); genitoventral plate little wider than anal plate (Fig. 214) ..... *furmani*, page 12

Dorsal plate rounded posteriorly (Fig. 42); genitoventral plate at least twice as wide as anal plate (Fig. 238) ..... *armatus*, page 12

KEY TO SPECIES OF MALE *Ischyropoda*

Expanded portion of posterior part of sternogenitoventral plate not wider than anterior part of plate (Fig. 353) ..... *furmani*

Expanded portion of posterior part of sternogenitoventral plate much wider than anterior part of plate (Fig. 351) ..... *armatus*

Ischyropoda furmani Keegan, 1956

Figs. 47, 74, 108, 169, 179, 208, 214 327, 353, 545, 600

Distribution. UTAH: San Juan Co.: *Onychomys leucogaster;* Tooele Co.: *Dipodomys ordii, Microdipodops megacephalus, O. leucogaster, Perognathus longimembris, Peromyscus maniculatus* (Keegan, 1956b), *Neotoma lepida* (Allred and Roscoe, 1957).

Other Utah records. San Juan Co.: *D. ordii, Perognathus* sp.

Seasonal occurrence. One male was taken in May, and five females in May and September.

Comments. Keegan (1956) listed *Microdipodops pallidus* as a host for this mite in Tooele County. This error of host identification inadvertantly supplied Keegan was corrected to *M. megacephalus* (Allred, 1965).

Ischyropoda armatus Keegan, 1951

Figs. 42, 69, 100, 106, 170, 217, 238, 326, 351, 374 458, 538, 547, 601

Distribution. ARIZONA: *Neotoma albigula;* CALIFORNIA: *Citellus* sp., *Dipodomys deserti, Dipodomys merriami, Perognathus californicus, Perognathus inornatus, Perognathus xanthonotus, Peromyscus* sp., *Thomomys bottae;* COLORADO: *Onychomys leucogaster, Thomomys umbrinus* (Keegan, 1951; Miller and Ward, 1960). NEVADA: *D. merriami, Dipodomys microps, Onychomys torridus, Perognathus formosus, Perognathus longimembris, Peromyscus crinitus* (Allred, 1962, 1963; Coates, 1963; Allred and Coates, 1964a). NEW MEXICO: *Peromyscus maniculatus, Thomomys* sp. (Keegan, 1951). OKLAHOMA: *Dipodomys ordii* (Ellis, 1960). TEXAS: *D. ordii, Dipodomys spectabilis, Neotoma micropus, O. leucogaster, Sylvilagus auduboni* (Eads, Menzies, and Miles, 1952). UTAH: *P. maniculatus* from the following counties: Beaver, Box Elder, Daggett, Duchesne, Kane, Morgan, Piute, Rich, Summit, Utah and Washington; Duchesne Co.: *Peromyscus truei;* Garfield Co.: *Peromyscus* sp. (Allred, 1957a). Tooele Co.: *D. microps, D. ordii, O. leucogaster* (Keegan, 1953), *P. formosus* (Ho, 1962). *Perognathus parvus* (Keegan, 1953), *P. maniculatus* (Woodbury, 1956b). Utah Co.: *D. microps* (Ho, 1962), *D. ordii, O. leucogaster, P. maniculatus* (Elzinga, 1960), *P. truei* (Allred, 1957a).

Other Utah records. Beaver Co.: *D. ordii.* Box Elder Co.: *D. microps, D. ordii, P. parvus.* Duchesne Co.: *D. ordii.* Garfield Co.: *Perognathus* sp. Iron Co.: *D. ordii, P. parvus.* Juab Co.: *D. microps, D. ordii, O. leucogaster, P. formosus, P. longimembris, P. parvus.* Kane Co.: *D. ordii, P. formosus, P. longimembris, P. parvus.* Millard Co.: *D. microps.* San Juan Co.: *D. ordii, O. leucogaster, Perognathus flavus.* Sanpete Co.: *D. microps, D. ordii.* Uintah Co.: *D. ordii.* Utah Co.: *Erethizon epixanthum, Lepus californicus, P. parvus.* Washington Co.: *Citellus variegatus, D. merriami, D. microps, Myotis californicus, O. leucogaster, O. torridus, P. formosus.* Wayne Co.: *D. ordii, P. parvus, P. maniculatus.*

Seasonal occurrence. Totals of 37 males, 134 females and 22 deutonymphs were collected. Males were taken from May through October, mostly in July; females from April through December, mostly in June and July; and deutonymphs from June through September, mostly in June.

Comments. Mites of *I. armatus* are widely distributed over the state, and are known from 20 counties.

This species apparently prefers grasshopper mice (*Onychomys* spp.) and pocket mice (*Perognathus* spp.) as its hosts. Its population index was 3 to 5 on *Onychomys*, 4 to 5 on *Perognathus*, two on *Dipodomys* and one on *Peromyscus*.

In half of its 75 collections, *I. armatus* was the only mite on its host.

KEY TO SPECIES OF FEMALE *Haemogamasus*

1. Sternal plate with accessory setae (Fig. 211) ..... *alaskensis*, page 13

   Sternal plate with only three usual pairs of setae (Fig. 212) 2

2. Posterior margin of sternal plate invaginated to level midway between first and second pairs of sternal setae (Fig. 204) ..... *pontiger*, page 13

   Posterior margin of sternal plate almost straight or not invaginated anterior to second pair of sternal setae (Fig. 206) 3

3. Some setae (especially posteriorly and on legs) with filamentous barbs (Fig. 207) 4

Setae lacking barbs, although few posteriorly may have minute teeth resembling bases of broken barbs ..... *liponyssoides*, page 14

4. First pair of sternal pores parallel with anterior margin of sternal plate (Fig. 202) ..... *ambulans*, page 14

First pair of sternal pores situated at angle to anterior margin of sternal plate (Fig. 207) ..... *longitarsus*, page 15

KEY TO SPECIES OF MALE *Haemogamasus*

1. Some accessory setae of holoventral plate situated anterior to level of coxa IV (Fig. 352) 2

Accessory setae of holoventral plate not anterior to coxa IV (Fig. 354) 4

2. Accessory setae of holoventral plate situated at anterior edge of plate opposite coxa II ..... *alaskensis*

Accessory setae of holoventral plate not at anterior edge of plate, not anterior to coxa III 3

3. Moveable digit of chelicera almost twice as long as fixed digit ..... *longitarsus*, page 15

Moveable digit only slightly longer than fixed digit ..... *ambulans*, page 14

4. Holoventral plate with less than 20 pairs of setae ..... *pontiger*

Holoventral plate with more than 40 pairs of setae ..... *liponyssoides*, page 14

Haemogamasus alaskensis Ewing, 1925

Figs. 45, 102, 110, 211, 226, 329, 543

In the series from Utah there is considerable variation. The number of accessory setae on the sternal plate varies from 22 to 25. Those on the genitoventral plate vary from 47 to 95. In some only the first sternal setae are barbed, whereas in others the first and second pairs are barbed.

Distribution. ILLINOIS: ? host; MAINE: *Clethrionomys gapperi, Myotis lucifugus, Napeozapus insignis* (Keegan, 1951). MARYLAND: *Microtus pennsylvanicus* (Drummond, 1957). MASSACHUSETTS: *C. gapperi, M. pennsylvanicus;* NEW YORK: *M. pennsylvanicus, Tamiasciurus hudsonicus, N. insignis* (Keegan, 1951; Whitaker, 1963). NORTH CAROLINA: *Microtus montanus;* PENNSYLVANIA: *C. gapperi* (Keegan, 1951). UTAH: Morgan Co.: *Blarina brevicauda* (Keegan, 1951). Salt Lake Co.: *Peromyscus maniculatus* (Allred, 1957b). WASHINGTON: *Microtus oregoni* (Keegan, 1951).

Other Utah records. Carbon Co.: *Microtus longicaudus, Zapus princeps.* Duchesne Co.: *Peromyscus* sp. Utah Co.: *Ochotona princeps.*

Seasonal occurrence. Two females were taken in June, three in July, and one deutonymph in July.

Comments. Mites were found only in the northern part of the state, but in both the Great and Upper Colorado River basins.

This species is associated with voles (*Microtus* spp.) and other rodents such as red-backed mice and jumping mice of a similar habitat in mountainous areas.

In one of the four collections this mite was the only species on its host. In one other collection it was associated with *Haemogamasus ambulans.*

Haemogamasus pontiger
(Berlese), 1903

Figs. 50, 115, 204, 243, 354, 552

Euhaemogamasus oudemansi of authors (Strandtmann and Wharton, 1958).

Distribution. COLORADO: *Tamiasciurus fremonti* (Keegan, 1951). NEVADA: *Neotoma lepida,*

Peromyscus crinitus (Allred and Goates, 1964a, 1964b). NEW YORK: ? host (Keegan, 1951). OREGON: *N. lepida* (Hansen, 1964). UTAH: Iron Co.: *Peromyscus maniculatus* (Allred, 1957b). Juab Co.: *N. lepida* (Allred and Beck, 1953a). Kane Co.: *P. maniculatus* (Allred, 1957b). Tooele Co.: *N. lepida* (Woodbury, 1956b). Utah Co.; *P. maniculatus;* Washington Co.: *Peromyscus eremicus* (Allred, 1957b).

Other Utah records. Carbon Co.: *P. maniculatus.* Kane Co.: *N. lepida.* Piute Co.: *N. lepida.* San Juan Co.: *Peromyscus boylii.* Utah Co.: *Eutamias quadrivittatus.*

Seasonal occurrence. Fourteen females and two males were taken from April through July, and in September and October. Two males were collected in May and July. Gravid females were taken in May and June.

Comments. Mites of *H. pontiger* likely are distributed over the entire state in both the Great and Upper Colorado River basins. They are known from eight counties.

This species apparently has a preference for white-footed mice and wood rats, particularly *P. boylii* and *N. lepida.*

In five of its 12 collections, *H. pontiger* was the only mite on its host.

Haemogamasus liponyssoides occidentalis Keegan, 1951

Figs. 48, 107, 206, 220, 377, 549

Euhaemogamasus liponyssoides occidentalis of authors (Strandtmann and Wharton, 1958).

Keegan (1951) designated a subspecies of *H. liponyssoides* Ewing, 1925 as *H. liponyssoides occidentalis.* He indicated that *H. liponyssoides* was principally eastern in its distribution, and *H. l. occidentalis* occurred in the western United States.

Distribution. CALIFORNIA: *Clethrionomys occidentalis, Microtus californicus, Neotoma fuscipes, Neurotrichus gibbsi, Scapanus latimanus, Sorex trowbridgii* (Keegan, 1951; Jameson and Brennan, 1957; Radovsky, 1960b). OREGON: *Microtus townsendii, Mustela saturata, Neurotrichus* sp., *Scapanus townsendii;* UTAH: Morgan Co.: *Blarina brevicauda;* WASHINGTON: *Scapanus orarius, S. townsendii, Thomomys fuscus* (Keegan, 1951).

Other Utah records. Utah Co.: *Microtus longicaudus.* Wayne Co.: *Microtus* sp.

Seasonal occurrence. Two females were taken in July and two in August.

Comments. Hansen (1964) listed *H. liponyssoides* from *M. longicaudus* and *Microtus montanus* from Oregon. These likely are *H. l. occidentalis.*

Haemogamasus ambulans (Thorell), 1872

Figs. 49, 51, 52, 53, 79, 112, 114, 116, 117, 191, 202, 210, 212, 218, 249, 252, 273, 284, 328, 352, 380, 383, 396, 400, 542, 544, 550, 559.

Euhaemogamasus ambulans of authors (Strandtmann and Wharton, 1958).

According to Strandtmann (personal correspondence), Russian workers interpret *H. ambulans* as possessing many accessory sternal setae. This is similar to what Keegan (1951) called *H. alaskensis. Haemogamasus ambulans* is also considered synonymous with *H. nidiformis* Bregetova. For the present we prefer to follow Keegan in the interpretation of the *Haemogamasus* forms.

There are four distinct forms of this species in the Utah series, herein designated as A, B, C and D. One significant difference between them is in the shape and size of the specialized seta on the fixed digit of the chelicera. In form A the chelicera is large, and the seta on the fixed digit is of normal shape. In the other three forms the chelicerae are smaller. In Form D the seta of the fixed digit is normal, but in forms B and C it is modified as a ribbon-shaped structure. The peritreme in forms B, C and D is narrow, whereas in form A it is large. In forms A, C and D the peritreme extends to the middle or anterior edge of coxa II, whereas in form B it extends only to the anterior edge of coxa III. On the genitoventral plate of forms A and B there are twice as many accessory setae as on forms C and D. The posterior margin of the sternal plate is invaginated to a point anterior to the level of the third pair of setae in forms A, C and D, but posterior to the third setae in form B.

These differences may be significant enough to warrant subspecific or even specific rank, but at present there is sufficient overlap to justify retention of these as morphological variants within the same species.

Distribution. CALIFORNIA: *Clethrionomys* sp., *Microtus californicus, Neotoma fuscipes, Peromyscus boylii, Sciurus griseus, Thomomys monticola* (Keegan, 1951; Jameson and Brennan, 1957). COLORADO: *Thomomys talpoides, Thomomys umbrinus* (Keegan, 1951; Miller and Ward, 1960). ILLINOIS: ? host; MARYLAND: Raccoon; MICHIGAN: *Sciurus niger;* MONTANA: *Sorex palustris;* NEW HAMPSHIRE: *Clethrionomys gapperi;* NEW YORK: *Tamiasciurus hudsonicus;* NORTH CAROLINA: "Birds;" OHIO: "Squirrel" (Keegan, 1951). OREGON: *Lagurus curtatus, Microtus longicaudus, Microtus montanus, Onychomys leucogaster, Peromyscus maniculatus, Sorex vagrans, T. talpoides, Zapus princeps* (Hansen, 1964). PENNSYLVANIA: *Glaucomys sabrinus;* SOUTH CARO-

LINA: "Squirrel" (Keegan, 1951). UTAH: Beaver Co.: *P. maniculatus* (Allred, 1957b). Cache Co.: *Neotoma cinerea* (Keegan, 1951). Daggett Co.: *P. maniculatus;* Iron Co.: *P. maniculatus* (Allred, 1957b). Juab Co.: *Neotoma lepida* (Allred and Beck, 1953a). Rich Co.: *P. maniculatus;* Salt Lake Co.: *P. maniculatus;* Sanpete Co.: *P. maniculatus;* Summit Co.: *P. maniculatus* (Allred, 1957b). Utah Co.: *Mus musculus* (Ho, 1962), *N. lepida* (Allred and Beck, 1953a), *P. maniculatus;* Wasatch Co.: *P. maniculatus* (Allred, 1957b.) VERMONT: *Glaucomys sabrinus;* VIRGINIA: *Glaucomys volans;* WASHINGTON: *Thomomys fuscus* (Keegan, 1951).

Other Utah records. Beaver Co.: *Citellus lateralis.* Box Elder Co.: *Dipodomys ordii, Perognathus parvus, P. maniculatus.* Carbon Co.: *M. longicaudus.* Daggett Co.: *G. sabrinus, Microtus* sp., *Z. princeps.* Duchesne Co.: *T. talpoides.* Grand Co.: *O. leucogaster.* Iron Co.: *Eutamias umbrinus.* Juab Co.: *D. ordii.* Kane Co.: *N. lepida, Peromyscus* sp. Morgan Co.: *P. maniculatus.* San Juan Co.: *N. cinerea, Thomomys bottae, T. talpoides.* Sanpete Co.: *T. talpoides.* Summit Co.: *Ochotona princeps.* Tooele Co.: *Peromyscus truei.* Utah Co.: *Citellus armatus, C. gapperi, M. montanus, N. cinerea, O. princeps, T. bottae, T. talpoides, Z. princeps.* Wasatch Co.: *T. hudsonicus, T. talpoides.* Washington Co.: *P. maniculatus.*

Seasonal occurrence. Totals of 96 females, one male and five deutonymphs were taken. The females were collected from March through August, and in November and December. Greatest numbers were taken in June, July and August. The male was taken in August, and the deutonymphs in June, July and August. Two females in June each contained an egg, and a female in August contained a larva. Early summer likely is the reproductive period for this species. The small number of males taken is indicative that they are nest dwellers.

Comments. Mites of *H. ambulans* were found more commonly in the northern part of Utah in the Great Basin. They are known from 20 counties.

This species was taken from a variety of rodents, but was most commonly associated with gophers (*Thomomys* spp.) and jumping mice (*Zapus* sp.). Squirrels (*Spermophilus* spp.) were also frequent hosts.

In 22 of 53 collections, *H. ambulans* was the only mite on its host. In four collections it was associated with other species of *Haemogamasus.*

Haemogamasus longitarsus
(Banks), 1910
Figs. 119, 207, 287

Euhaemogamasus barberi of authors (Strandtmann and Wharton, 1958; Johnston, 1959).

One specimen from Utah has barbs on the first two pairs of sternal setae rather than just on the first as is apparently typical.

Distribution. ? hosts from DELAWARE, MARYLAND, NEW YORK, and VIRGINIA (Keegan, 1951). ? locality from *Blarina brevicauda, Citellus richardsoni, Microtus pennsylvanicus* (Strandtmann and Wharton, 1958). MARYLAND: *Pitymys pinetorum* (Drummond, 1957). UTAH: Utah Co.: *Peromyscus maniculatus* (Allred, 1957b).

Other Utah records. Box Elder Co.: *P. maniculatus.* Cache Co.: *Thomomys talpoides.* Daggett Co.: *P. maniculatus.* Garfield Co.: *Microtus longicaudus.* Utah Co.: *Thomomys* sp.

Seasonal occurrence. Four females were taken in June and two in July.

Comments. Mites of this species were more common in northern than in southern Utah, and are known from both the Great and Upper Colorado River basins. They are known from only five counties.

In its six collections *H. longitarsus* was associated with mites of other species.

Phytoseiidae Berlese, 1916
Fig. 193

This family includes mites which are predaceous, most frequently found on plants where they attack phytophagus mites. Inasmuch as small mammals frequently transport plants and seeds into their burrows and nests, these mites are occasionally found associated with them.

KEY FOR THE SEPARATION OF FEMALES OF THE GENUS *Kleemania* FROM OTHER GENERA OF THE FAMILIES PHYTOSEIIDAE, AMBLYSEIIDAE, AND BLATTISOCIDAE

Sternal plate with pattern resembling three asymmetrical cog-wheels (Fig. 262) ..... *Kleemania,* page 16

Sternal plate lacking such pattern ..... genera other than *Kleemania*

Kleemania sp.

Figs. 156, 262, 319

Distribution. NEVADA: *Dipodomys merriami, Dipodomys microps, Onychomys torridus, Perognathus formosus, Perognathus longimembris, Peromyscus crinitus, Peromyscus maniculatus, Peromyscus truei* (Allred, 1962, 1963; Goates, 1963; Allred and Goates, 1964a). UTAH: Tooele Co.: *Dipodomys ordii, Onychomys leucogaster, P. formosus, P. longimembris, P. crinitus, P. maniculatus* (Woodbury, 1956b). Utah Co.: ? host (Elzinga, 1960).

Other Utah records. Box Elder Co.: *D. ordii, Perognathus parvus.* Carbon Co.: *Eutamias minimus.* Daggett Co.: *D. ordii.* Duchesne Co.: *Citellus lateralis.* Emery Co.: *D. ordii, P. crinitus.* Juab Co.: *D. microps, D. ordii, P. parvus, P. maniculatus.* Kane Co.: *D. ordii, P. longimembris, P. maniculatus.* Millard Co.: *D. microps.* San Juan Co.: *D. ordii, O. leucogaster.* Utah Co.: *P. maniculatus.* Wayne Co.: *P. maniculatus.*

Seasonal occurrence. The 88 females were taken from May through September, mostly in June.

Comments. Mites of this species are distributed over the state in 12 counties.

In seven of 33 collections *Kleemania* sp. was the only mite on its host.

There is some question as to the parasitic nature of these mites. Likely they are predaceous, but because of their common occurrence on rodents, they are included here.

DERMANYSSIDAE Kolenati, 1859

This family represents a diverse group of mites parasitic on a variety of animals. They are worldwide in distribution and may be commonly found on mammals.

KEY TO GENERA OF FEMALE DERMANYSSIDAE

1. Anal plate more than half as wide as body, concave on anterior margin (Fig. 111) ..... *Myonyssus*, page 17

   Anal plate narrow, convex or rarely truncate on anterior margin (Fig. 113) 2

2. Coxa III with one or more spurs or slight semi-circular protuberance on posteromedian side (Fig. 468) 3

   Coxa III lacks spur or protuberance 4

3. Coxa III with well-formed spur (Fig. 468) ..... *Hirstionyssus*, page 17

   Coxa III with rounded protuberance ..... *Ichoronyssus*, page 31

4. Chelicera filamentous, very long; chela so minute as to be almost indiscernible (Fig. 389) ..... *Dermanyssus*, page 31

   Chelicera not as above, with distinct and well-formed chela (Fig. 386) 5

5. With two dorsal plates (Figs. 32, 35) 6

   With one dorsal plate (Fig. 40) 7

6. Posterior dorsal plate large, longer than anal plate (Fig. 35) ..... *Steatonyssus*, page 32

   Posterior dorsal plate small, shorter than anal plate (Fig. 37) ..... *Ornithonyssus*, page 32

7. Anterior pair of sternal pores situated against lateral margins of plate resulting in lateral projections of plate for their accommodation (Fig. 248); third sternal setae on separate, small, distinct plates (Fig. 248) ..... *Ichoronyssus*, page 31

   Anterior pair of pores not against edge of plate which is without lateral projections for their accommodation; third sternal setae, if not on plate, not on distinct separate plates (Fig. 257) ..... *Ornithonyssus*, page 32

Myonyssus montanus
Furman and Tipton, 1955
Figs. 111, 219, 255, 564

Distribution. UTAH: San Juan Co.: *Ochotona princeps* (Furman and Tipton, 1955).

Other Utah records. Summit Co.: *O. princeps*.

Seasonal occurrence. Three females were taken in August.

KEY TO SPECIES OF FEMALE *Hirstionyssus*

1. Tarsus II has apical spurs (Fig. 606) 2
   Tarsus II lacks spurs 13

2. Coxa I has spur (Fig. 436); inner spurs of coxae II and III bifid (Figs. 457, 460) ..... *staffordi*, page 18
   Coxa I lacks spur; other coxal spurs simple (Fig. 463) 3

3. Coxa II has two spurs (Fig. 450) 4
   Coxa II has three spurs (Fig. 442) 11

4. Coxa III has one spur (Fig. 461) ..... *tarsalis*, page 18
   Coxa III has two spurs (Fig. 463) 5

5. Coxa IV lacks spur 6
   Coxa IV has spur (Fig. 514) 7

6. Inner spurs on coxae II and III rounded or truncate (Figs. 456, 462) ..... *affinis*, page 19
   Inner spurs on coxae II and III sharply pointed (Fig. 455) ..... *palustris*, page 19

7. Inner spur on coxa II broadly rounded (Fig. 454) ..... *punctatus*, page 20
   Inner spur on coxa II acutely or bluntly pointed (Figs. 451, 452) 8

8. Sternal plate seven times as wide as long; posterior border invaginated to level anterior to second sternal setae (Fig. 225) ..... *invaginatus*, page 21
   Sternal plate less than six times as wide as long; posterior border not invaginated beyond level of second sternal setae (Fig. 228) 9

9. Peritreme does not extend beyond anterior edge of coxa II (Fig. 555) ..... *eutamiae*, page 21
   Peritreme extends to middle of coxa I 10

10. Inner spur of coxa II short (not over 8 mm long), about as wide as long (Fig. 450) ..... *utahensis*, page 22
    Inner spur of coxa II long (about 18 mm long), much longer than wide (Fig. 449) ..... *angustus*, page 24

11. Femur II has blunt spur near anterior margin (Fig. 540) *femuralis*, page 25
    Femur II lacks spur 12

12. Inner spurs of coxae II and III broadly rounded (Fig. 447) ..... *longichelae*, page 25

Inner spurs of coxae II and III bluntly pointed (Fig. 446) ... *thomomys*, page 26

13. Coxa II has two spurs ... 14

Coxa II has three spurs ... 17

14. Coxa IV has spur ... 15

Coxa IV lacks spur ... 16

15. Inner spur of coxa II represented only by slightly raised hump (Fig. 445) ... *torus*, page 27

Inner spur of coxa II distinct, pointed spur (Fig. 444) ... *neotomae*, page 29

16. Genitoventral plate has two pairs of setae (Fig. 299) ... *bisetosus*, page 29

Genitoventral plate has only usual pair of setae (Fig. 295) *isabellinus*, page 29

17. Peritreme very wide for entire length, equal to almost half the thickness of legs (Fig. 569) ... *triacanthus*, page 30

Peritreme of normal width or only slightly widened (Fig. 568) ... 18

18. Sternal plate less than four times as wide as long (Fig. 244) ... *hilli* variant, page 30

Sternal plate four or more times as wide as long ... 19

19. Peritreme ends at anterior edge of coxa II (Fig. 573); sternal plate about five times as wide as long (Fig. 242) ... *hilli*, page 30

Peritreme ends at middle of coxa I (Fig. 575); sternal plate about eight times as wide as long (Fig. 245) ... *incomptus*, page 30

Hirstionyssus staffordi
Strandtmann and Hunt, 1951

Figs. 12, 122, 213, 282, 436, 457, 460, 479, 602

Distribution. GEORGIA: *Mephitis elongata, Spilogale putorius*; OKLAHOMA: *Spilogale interrupta*; TEXAS: *Mephitis mesomelas, Spilogale leucoparia* (Strandtmann and Hunt, 1951).

Utah records. Utah Co.: *Spilogale gracilis*.

Seasonal occurrence. The 19 females were taken in July. Each of 12 contained an egg.

Comments. This mite likely is more common and widely distributed than has been reported. An obvious reluctance on the part of scientists to collect and examine its common host likely accounts for the few records available.

Hirstionyssus tarsalis, new species

Figs. 13, 123, 215, 270, 459, 461, 563, 603

Utah records. Box Elder Co.: *Peromyscus maniculatus*, Lynn, two females, July, 1957. Daggett Co.: *P. maniculatus*, Deep Creek Camp Ground, one female, June, 1958.

Type data. Holotype female, B.Y.U. collection no. 445. Taken from *Peromyscus maniculatus*, Deep Creek Camp Ground, Daggett Co., Utah, 23 June 1958. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *tarsalis* refers to tarsus IV which possesses a long spur-like seta.

Female

Gnathosoma. Greatest width at base, 94; length to base of palpal trochanter, 58. All setae nude. Cheliceral digits moderate in length and thickness, 50 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 218; II, 185; III, 197; IV, 271. Width of genua: I and II, 58; III, 43; IV, 41. Tarsus II has pair of apical, slightly curved, blunt spurs, 8 long. Tarsus IV has apical, spur-like seta, 22 long. Coxa I has two subequal setae, proximal one slightly larger. Coxa II has two

spurs: usual anterocaudal one of moderate thickness and sharply pointed; inner spur bluntly pointed, 7 long and 7 wide. Coxa III has one inner posterior spur, sharply pointed, 12 long and 7 wide. Coxa IV lacks spur.

Dorsal plate. Elliptical; all sides convex; tapers to blunt point posteriorly; 480 long, greatest width 268. Has 26 pairs setae; most anterior pair 17 long, anteromedial setae 31 long, medial setae 12 long, posterior ones 21 long.

Sternal plate. Five times as wide as long (width measured between outer edges of third sternal setae); anterior border only slightly convex; posterior border concave, invaginated to level even with second sternal seta; lateral margins moderately concave; anterior corners elongate and sharply pointed; posterior corners narrowly extend between coxae II and III. Has three pairs subequal setae, first and third pairs about 29, middle pair about 36 long; distance between posterior pair of setae 2.7 times as great as distance between first pair; first pair of setae on anterior margin of plate, second pair set in from lateral margins, third pair on posterior edge of plate.

Genitoventral plate. Width 79 (measured between outer edges of genitoventral setae); length 86 (from anterior edge of genitoventral seta to posterior border of plate); has prominent internal ridges; has narrow, darkened border effect; thickly punctate; setae 24 long, situated slightly posterior to mid-coxa IV.

Anal plate. Elongate oval; evenly convex but more strongly posteriorly; with cribum. Length 65 (from base of postanal seta to anterior edge of plate); greatest width 55; has light border completely encircling plate; lightly punctate. Adanal and postanal setae subequal, about 19 long; adanal setae situated opposite middle of anus.

Unsclerotized part of venter. Has 13 pairs of setae posterior to genitoventral setae (not counting those on posterior borders); setae about equal, 24 long.

Peritreme. Sinuous, ends at anterior fourth of coxa I; granulo-punctate for entire width and length; about equal width (5 wide) for entire length.

Hirstionyssus affinis (Jameson), 1950

Figs. 14, 124, 221, 286, 456, 462, 556, 604

Distribution. CALIFORNIA: *Eutamias minimus, Peromyscus boylii, Tamiasciurus douglasii* (Jameson, 1950b; Strandtmann and Wharton, 1958).

Utah records. Box Elder Co.: *E. minimus.* Kane Co.: *Perognathus formosus, Peromyscus truei.*

Seasonal occurrence. Seven females and six protonymphs were taken in June and July.

Comments. Little is known about the host relationships of this species.

In two of the three collections, *H. affinis* was the only mite on its host. In one collection it was associated with *Hirstionyssus utahensis.*

Hirstionyssus palustris, new species

Figs. 15, 131, 222, 261, 455, 463, 558, 605

Utah records. Carbon Co.: *Sorex palustris,* three miles south of Scofield, two females, July, 1960.

Type data. Holotype female, B.Y.U. collection no. 4808. Taken from *Sorex palustris,* 3 mi south of Scofield, Carbon Co., Utah, 29 July 1960, by D Elden Beck and Clyde L. Pritchett. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *palustris* is Latin for "marshy," and refers to the habitat of the type host.

Female

Gnathosoma. Greatest width at base, 73; length to base of papal trochanter, 70. All setae nude. Cheliceral digits 47 long from base of moveable digit, moderate in thickness, lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 273; II, 225; III, 200; IV, 275. Width of genua: I and II, 53; III, 45; IV, 43. Tarsus II has apical spurs of medium size and slightly curved. Coxa I has two subequal setae, about 28 long. Coxa II has two spurs: usual anterocaudal spur sharply pointed, about 20 long; inner spur sharply pointed, 18 long and 11 wide. Coxa III has two spurs: outer posterior one sharply pointed, 10 long and 5 wide; inner spur sharply pointed, 18 long and 10 wide. Coxa IV lacks spur.

Dorsal plate. Covers most of dorsum; sides parallel for two-thirds of length; tapers to blunt tip; 510 long; greatest width 290. Has approximately 23 pairs of delicate subequal setae, 10 to 15 long, except for anteromedial and terminal ones which are slightly larger, 15 to 20 long.

Sternal plate. Three and eight-tenths times as wide as long (width measured between outer edges of third sternal setae); anterior border slightly convex; posterior border concave, invaginated almost to level of second setae; lateral margins concave; anterior corners sharply pointed, extend between coxae I and II; pos-

terior corners sharply pointed, extend between coxae II and III. Has three pairs of setae: anterior pair 49 long, median pair 50, posterior pair 45; distance between posterior pair of setae slightly more than twice distanee between anterior pair; first pair of setae on anterior edge of plate, second pair set in from sides, third pair situated on extreme posterior corners.

Genitoventral plate. Width 88 (measured between outer edges of genitoventral setae); length 133 (from anterior edge of genitoventral seta to posterior border of plate); broadly rounded, almost truncate; has prominent internal ridges; has distinct light border; setae 30 long, situated at level opposite middle of coxa IV.

Anal plate. Sub-oval, sides broadly rounded, anterior edge almost truncate. Has narrow eribum, 13 long. Length 75 (from base of postanal seta to anterior edge of plate); greatest width, 75; has distinct darkened border. Adanal and postanal setae subequal, 24 to 25 long; adanal setae situated at level opposite middle of anus.

Unselerotized part of venter. Has 15 pairs of setae between level of genitoventral seta and posterior end of anal plate, not counting peripheral setae; those closest to genitoventral plate 30 long, others 20 to 25 long.

Peritreme. Sinuous, narrow, extends to middle of coxa I.

Hirstionyssus punctatus, new species

Figs. 16, 125, 224, 258, 454, 467, 483, 562, 606

Utah records. Box Elder Co.: *Eutamias minimus*, Lynn, one female, July, 1957. Daggett Co.: *Glaucomys sabrinus*, Deep Creek Campground, six females (each of three with an egg), June, 1958. Kane Co.: *Peromyscus maniculatus*, head of Cottonwood Creek, six females, two deutonymphs, June, 1958. Summit Co.: *Eutamias quadrivittatus*, Bald Mtn., 14 females, August, 1957.

Type data. Holotype female, from *Eutamias quadrivittatus*, Bald Mtn., Summitt Co., Utah, 25 August 1956. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *punctatus* refers to the punctation of the anal plate.

Female

Gnathosoma. Greatest width at base, 115; length to base of palpal trochanter, 77. All setae nude. Cheliceral digits moderate in length and thickness, 60 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 370; II, 320; III, 285; IV, 406. Width of genua: I, 58; II, 62; III, 46; IV, 43. Tarsus II has pair of apical, slightly curved, blunt spurs, 9.6 long. Tarsus IV has apical, spur-like seta, 17 long. Coxa I has two subequal setae, proximal one slightly longer. Coxa II has two spurs: usual anterocaudal one long and sharply pointed; inner spur thumb-like, broadly rounded, almost truncate, 14 long, 12 wide. Coxa III has two spurs: outer posterior one sharply pointed, 12 long and 7 wide; inner posterior one bluntly pointed, 14 long and 12 wide. Coxa IV has sharply pointed spur, 13 long and 7 wide.

Dorsal plate. Sides neither concave nor convex, but slightly sinuous; tapers to blunt point; 558 long; greatest width, 330. Has 26 pairs of setae; most anterior pair 16 long, anteromedial setae 31 long, medial setae 16 long, posterior ones 31 long.

Sternal plate. Three and nine-tenths times as wide as long (width measured between outer edges of third sternal setae); anterior border convex; posterior border concave, invaginated to level almost to second setae; lateral margins moderately concave; anterior corners elongate but bluntly pointed; posterior corners narrowly extend along anterior margins of coxae III. Has three pairs of subequal setae, third pair slightly longer than first and second; distance between posterior pair of setae 2.8 times as great as distance between first pair; first pair of setae on anterior margin of plate, second pair set in considerably from lateral margins, third pair set in from posterior margin.

Genitoventral plate. Width 98 (measured between outer edges of genitoventral setae); length 127 (from anterior edge of genitoventral seta to posterior border of plate); has conspicuous internal ridges; has narrow, darkened border effect; lightly punctate. Setae 34 long, situated at level opposite mid-coxa IV.

Anal plate. Elongate oval; evenly convex but more strongly tapered posteriorly. With eribum. Length 77 (from base of postanal seta to anterior edge of plate); greatest width 72; has dark border completely encircling plate; lightly but thickly punctate. Adanal and postanal setae subequal, about 31 long; adanal setae situated opposite middle of anus.

Unselerotized part of venter. Has 15 pairs of setae posterior to genitoventral setae (not counting those on posterior borders); setae about equal, 31 long.

Peritreme. Slightly sinuous; ends at anterior fourth of coxa II; granulo-punctate for entire width and length; 9.6 wide at base, gradually tapering to 4.8 at tip.

Hirstionyssus invaginatus, new species

Figs. 17, 18, 127, 130, 225, 227, 267, 276, 452, 453, 464, 468, 484, 485, 560, 561, 607, 608

Hirstionyssus occidentalis (Ewing) of Utah records (in part).

Utah records. Cache Co.: *Citellus armatus*, Blacksmith Fork Junction, one female, June, 1953. Rich Co.: *C. armatus*, Laketown, seven females, June, 1953. Sanpete Co.: *C. armatus*, 11 miles east of Mt. Pleasant, one male, one female, August, 1951. Summit Co.: *C. armatus*, Lake Creek Summit, 19 females, August, 1953. Utah Co.: *C. armatus*, Provo Canyon, 12 females, June, 1951 and 1957; five females, July, 1957; *Mus musculus*, Lehi, two females, one deutonymph, January, 1951; *Thomomys talpoides*, Provo Canyon, one female, July, 1956. Wasatch Co.: *C. armatus*, Currant Creek, two males, five females, June, 1953; Soldier's Summit, two females, June, 1951; Strawberry Reservoir, nine females, June, 1951.

Comments. Apparently this mite prefers the squirrel *Citellus armatus* as its host.

In five of 17 collections, *H. invaginatus* was the only mite on its host. In five collections it was associated with other species of *Hirstionyssus*.

Type data. Holotype female, B.Y.U. collection no. 4117. Taken from *Citellus armatus* 3 mi west of Big Tree Camp, Provo Canyon, Utah Co., Utah, 22 July 1956, by Dorald M. Allred. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *invaginatus* refers to the extreme invagination of the posterior border of the sternal plate.

Female

Gnathosoma. Greatest width at base, 92; length to base of palpal trochanter, 73. All setae nude. Cheliceral digits 48 from base of moveable digit, moderately developed, lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 345; II, 298; III, 275; IV, 375. Width of genua: I and II, 55; III and IV, 43. Tarsus II has pair of medium-sized, slightly curved apical spurs. Coxa I has two setae: distal one 22 long, proximal one 30. Coxa II has two spurs: usual anterocaudal spur sharply pointed, 25 long; inner spur sharply pointed, 23 long and 20 wide. Coxa III has two spurs: outer posterior one sharply pointed, 10 long and 6 wide; inner spur sharply pointed, 20 long and 10 wide. Coxa IV has posterocaudal spur, 12 long and 6 wide.

Dorsal plate. Elliptical, covers most of dorsum except sides and posterior corners; lateral margins parallel, straight or slightly concave, with distinct thickened border; tapers to blunt tip; 554 long; greatest width 304; has 25 pairs of setae, those on periphery largest; peripheral setae 20 to 25 long, terminal pair 30 long, medial setae 10 to 13 long.

Sternal plate. Almost seven times as wide as long (width measured between outer edges of third sternal setae); anterior border slightly convex; posterior border concave, invaginated to level slightly anterior to second pair of setae; lateral margins straight; anterior and posterior borders of plate slightly darkened; anterior corners sharply pointed, extend between coxae I and II; posterior corners sharply pointed, extend laterally between coxae II and III; has three pairs of subequal setae, 37 to 40 long; distance between posterior pair of setae two and one-half times as great as distance between first pair; first pair of setae on anterior edge of plate; second pair set in from sides; third pair near edge of posterior corners.

Genitoventral plate. Width 93 (measured between outer edges of genitoventral setae); length 120 (from anterior edge of genitoventral setae to posterior tip of plate); slightly expanded behind genitoventral setae, tapers abruptly (almost straight) to blunt, rounded tip; has distinct internal ridges and light border edged inwardly with darkened line; setae 25 long, situated at level about midway opposite coxa IV.

Anal plate. Suboval, sides and anterior edge broadly rounded; tapers to broadly rounded tip. Cribum 17 long. Length 68 (from base of postanal seta to anterior edge of plate); greatest width 72; has distinct dark border. Adanal setae 28 long; postanal seta heavier, 30 long; adanal setae situated at level opposite middle of anus.

Unsclerotized part of venter. Has 12 pairs of setae between level of genitoventral setae and posterior tip of anal plate, not counting peripheral setae; setae subequal, 20 to 30 long.

Peritreme. Sinuous, curved, wider at base, tapers gradually to moderate width; extends to middle of coxa I.

Hirstionyssus cutamiae, new species

Figs. 19, 128, 228, 279, 451, 469, 482, 555, 609

Hirstionyssus occidentalis (Ewing) of Utah records (in part).

Utah records. Utah Co.: *Eutamias quadrivittatus*, Rock Canyon, Provo, one female, October, 1956; Sco-

field Reservoir, eight females, June, 1957; *Reithrodontomys megalotis*, Cedar Valley, one female, November, 1952.

Type data. Holotype female, B.Y.U. collection no. 4778. Taken from *Eutamias* sp., Aspen Grove, Utah Co., Utah, 16 October 1956, by Lawrence Tseu. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *eutamiae* refers to the generic name of the type host.

Female

Gnathosoma. Greatest width at base, 90; length to base of palpal trochanter, 72. All setae nude. Cheliceral digits 78 from base of moveable digit, strongly developed, lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 308; II and III, 264; IV, 352. Width of genua: I, 48; II, 50; III, 40; IV, 38. Tarsus II has small pair of apical claws. Coxa I has two subequal setae, 22 long. Coxa II has two spurs: usual anterocaudal spur sharply pointed, about 22 long; inner spur sharply pointed, 10 long and 8 wide. Coxa III has two spurs: outer posterior one sharply pointed, 10 long and 5 wide; inner spur sharply pointed, 12 long and 10 wide. Coxa IV has posteromarginal spur, 5 long and 5 wide, which may be branched or double in some specimens.

Dorsal plate. Covers all of dorsum except posterior corners; sides parallel for two-thirds length; tapers to blunt tip; 524 long; greatest width 334; has distinct light border; has about 26 pairs of delicate setae, those on periphery and posterior tip of plate largest: medial setae 12 to 18, peripheral setae 20 to 30.

Sternal plate. Slightly more than three and one-half times as wide as long (width measured between outer edges of third sternal setae); anterior border convex; blunt projection tapers anteriorly from first pair of setae; posterior border concave, invaginated to level almost equal with second pair of setae; lateral margins straight, with darkened borders; anterior corners sharply pointed, extend between coxae I and II; posterior corners sharply pointed, extend between coxae II and III. Has three pairs of subequal setae, 35 to 38 long; distance between posterior pair two and one-half times as great as distance between first pair; first pair of setae on anterior edge of plate, second pair set in from edge, third pair slightly in from edges of posterior corners.

Genitoventral plate. Width 95 (measured between outer edges of genitoventral setae); length 113 (from anterior edge of genitoventral setae to posterior tip of plate); slightly expanded behind genitoventral setae; tapers abruptly to blunt tip; has prominent internal ridges; setae 25 long, situated at level near posterior border of coxae IV.

Anal plate. Suboval, sides and anterior edge broadly rounded; tapers to blunt tip. Cribum 21 long. Length 73 (from base of postanal seta to anterior edge of plate); greatest width 67; has distinct dark border. Adanal and postanal setae subequal, 28 long; adanal setae situated at level opposite middle of anus.

Unsclerotized part of venter. Has 11 pairs of setae between level of genitoventral setae and posterior end of anal plate, not counting peripheral setae; setae subequal, 25 to 27 long.

Peritreme. Sinuous, narrow, extends to anterior edge of coxa II.

Hirstionyssus utahensis, new species

Figs. 20, 88, 129, 187, 229, 264, 334, 355, 450, 470, 486, 489, 495, 501, 516, 524, 557, 610

Hirstionyssus occidentalis (Ewing) of Utah records (in part).

Distribution. UTAH: Every county except Cache, Davis, Grand, Juab, Millard, Rich, Salt Lake, Sanpete and Wasatch: *Peromyscus maniculatus* (Allred, 1957c). Juab Co.: *Neotoma lepida* (Howell, Allred, and Beck, 1957). San Juan Co.: *Peromyscus crinitus* (Allred, 1957c). Tooele Co.: *Dipodomys microps, Dipodomys ordii* (Ho, 1962); *N. lepida, P. crinitus, Peromyscus truei* (Woodbury, 1956b). Utah Co.: *D. microps, D. ordii*, (Ho, 1962); *P. maniculatus* (Elzinga, 1960); *Reithrodontomys megalotis* (Elzinga and Rees, 1964). Washington Co.: *Peromyscus eremicus;* Wayne Co.: *P. crinitus* (Allred, 1957c).

Other Utah records. Beaver Co.: *Citellus lateralis*. Carbon Co.: *C. lateralis, R. megalotis*. Daggett Co.: *Eutamias quadrivittatus*. Duchesne Co.: *Citellus tridecemlineatus, Eutamias minimus, E. quadrivittatus*. Juab Co.: *P. maniculatus*. Kane Co.: *N. lepida, Perognathus longimembris, P. crinitus, P. truei*. San Juan Co.: *D. ordii, E. minimus, E. quadrivittatus, P. truei*. Sanpete Co.: *Citellus armatus, E. quadrivittatus*. Sevier Co.: *E. minimus, E. quadrivittatus*. Summit Co.: *C. armatus, C. lateralis, E. minimus, E. quadrivittatus*. Uintah Co.: *D. ordii*. Utah Co.: *C. armatus, C. lateralis, E. quadrivittatus, Thomomys talpoides*. Wasatch Co.: *C. armatus*. Wayne Co.: *Eutamias* sp., *P. truei*.

Seasonal occurrence. Totals of 55 males, 465 females and 33 deutonymphs were taken. Males were found in June, August, and October, mostly in June; females from March through August and in October, mostly in June; deutonymphs about equally in June and August. Each of two females in June contained an egg.

Comments. Mites of *H. utahensis* are widely distributed over the state, and are known from 23 counties.

This species is known from a variety of rodents but apparently prefers squirrels (*Citellus* spp.) and chipmunks (*Eutamias* spp.)

In 21 of 72 collections, *H. utahensis* was the only mite on its host. In 15 collections it was associated with other species of *Hirstionyssus*.

At the time of Allred's (1957c) work on this group, there was some doubt as to the placement of specimens tentatively identified as *H. occidentalis*. Further study of these by the senior author has led us to erect three species, *H. invaginatus*, *H. eutamiae*, and *H. utahensis*, to represent this complex heretofore reported as *H. occidentalis*. *Hirstionyssus utahensis* represents by far the majority of collections previously identified as *H. occidentalis*.

Type data. Holotype female, B.Y.U. collection no. 4224. Taken from *Eutamias quadrivittatus*, one-half mile east of Bald Mtn., Summit Co., Utah, 8 August 1957, by Dorald M. Allred and Merlin Killpack. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Allotype male, taken from *Peromyscus maniculatus*, Pleasant Grove, Utah Co., Utah, 7 October 1961, by Donald Ash. Same depository as holotype. The trivial name *utahensis*, referring to the state of Utah, was given because of the common occurrence and wide geographic distribution of this species in Utah.

Female

Gnathosoma. Greatest width at base, 93; length to base of palpal trochanter, 72. All setae nude. Cheliceral digits 75 from base of moveable digit, moderately developed, lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 303; II, 242; III, 237; IV, 293. Width of genua: I and II, 47; III and IV, 35. Tarsus II has pair of small, slightly curved apical spurs. Coxa I has two subequal setae, 25 long. Coxa II has two spurs: usual anterocaudal spur sharply pointed, about 20 long; inner spur sharply pointed, 7½ long and 7½ wide. Coxa III has two spurs: outer posterior one sharply pointed, 7½ long and 4 wide; inner spur sharply pointed, 12½ long and 8 wide. Coxa IV has caudomarginal spur, 10 long and 8 wide.

Dorsal plate. Elliptical, covers most of dorsum except sides and posterior corners; sides parallel for only short distance; tapers to blunt tip; 515 long; greatest width 290; has distinct light border; has 25 pairs of delicate setae, those on periphery only slightly larger than medial setae, except on anterior and posterior ends of plate: medial and mediolateral setae 12 to 15 long; anterior and posterior setae 22 to 27.

Sternal plate. Four and one-half times as wide as long (width measured between outer edges of third sternal setae); anterior border slightly and evenly convex; posterior border concave, invaginated to level almost even with second sternal setae; lateral margins almost straight, with slightly darkened borders; anterior corners sharply pointed, elongate, project between coxae I and II; posterior corners sharply pointed, extend laterally between coxae II and III; has three pairs of subequal setae 32 to 35 long; distance between posterior pair of setae three times as great as distance between first pair; first pair of setae on anterior edge of plate, second pair set in from edge, third pair slightly in from edges of posterior corners.

Genitoventral plate. Width 87 (measured between outer edges of genitoventral setae); length 110 (from anterior edge of genitoventral seta to posterior tip of plate); slightly expanded behind genitoventral setae, curves gradually to rounded tip; has prominent internal ridges and distinct, light border; setae 28 long, situated at level near posterior border of coxa IV.

Anal plate. Suboval, sides and anterior edge broadly rounded; tapers to bluntly pointed tip. Cribum 15 long. Length 70 (from base of postanal seta to anterior edge of plate); greatest width 63; has distinct dark border. Adanal and postanal setae subequal, 23 to 28 long; adanal setae situated at level opposite middle of anus.

Unsclerotized part of venter. Has 12 pairs of setae between level of genitoventral setae and posterior end of anal plate, not counting peripheral setae; setae subequal, 23 to 25 long.

Peritreme. Slightly sinuous, curved, of normal width, extends to middle of coxa I.

Male

Gnathosoma. Greatest width at base, 86; length to base of palpal trochanter, 58. All setae nude. Cheliceral digits 50 long from base of moveable digit; moderately thick; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 257; II, 228; III, 226; IV, 317. Width of genua: I, 53; II, 58; III and IV, 46. Tarsus II has pair of apical spurs. Coxa I has two subequal setae, 22 long. Coxa II has

two spurs: anterocaudal one sharply pointed, 19 long and 9 wide; inner medial spur represented only by bluntly pointed, minute projection about 2 long. Coxa III has two spurs: outer posterior one sharply pointed, 10 long and 5 wide; inner spur sharply pointed, 7 long and 5 wide. Coxa IV has narrow, sharply pointed spur, 12 long and 4 wide.

Dorsal plate. Elliptical; tapers posteriorly to blunt tip; 447 long; greatest width 265. Has 27 or 28 pairs of setae: anterior, anterolateral, and posterior setae largest, 19 to 31 long; posterolateral and medial setae smaller, 7 to 12 long.

Holoventral plate. Three usual ventral plates fused into one; 351 long; 131 wide at level of coxa III. Has eight pairs of subequal setae plus three anal setae, 19 long.

Unsclerotized part of venter. Has seven or eight pairs of subequal setae anterior to posterior edge of holoventral plate, 24 long.

Peritreme. Narrow, sinuous, ends at middle of coxa I.

Deutonymph

Gnathosoma. Greatest width at base, 82; length to base of palpal trochanter, 62. All setae nude. Cheliceral digits 43 long from base of moveable digit; slender; lack teeth.

Legs. Length from distal edge of coxa to base to pretarsus: I, 218; II, 214; III, 209; IV, 250. Width of genua: I, 48; II, 53; III, 46; IV, 43. Tarsus II lacks apical spurs. Coxa I has two subequal setae, 19 long. Coxa II has two spurs: anterocaudal one sharply pointed, 12 long and 7 wide; inner medial spur sharply pointed, 7 long and 5 wide. Coxa III has medial spur, sharply pointed, 10 long and 8 wide. Coxa IV lacks spur.

Dorsal plate. Elliptical; tapers to blunt tip posteriorly; 329 long; greatest width 173. Has 24 pairs of setae: posterior pair largest, 34 long; anterior and anterolateral setae subequal, 12 to 14 long; other setae smaller, 5 to 7 long.

Sterno-genitoventral plate. Ends at level opposite mid coxa IV; length 149; greatest width at level of coxa II, 96. Has four pairs of setae: anterior pair largest, 16 long; posterior pair smallest, 11 long.

Anal plate. Length 36 (from base of postanal seta to anterior margin of plate); greatest width 38. Cribum, 12 long. Anal setae subequal, 14 long; adanal setae near anterior level of anus.

Unsclerotized part of venter. Has 17 or 18 pairs of subequal setae, 7 to 17 long.

Peritreme. Narrow, slightly sinuous, extends to anterior fourth of coxa II.

Hirstionyssus angustus, new species
Figs. 21, 132, 233, 294, 449, 472, 565, 611

Utah records. Utah Co.: *Citellus armatus*, Colton, one female, July, 1960.

Type data. Holotype female, B.Y.U. collection no. 6516. Taken from *Citellus armatus*, Colton, Spanish Fork Canyon, Utah Co., Utah, 7 July 1960, by D Elden Beck. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *angustus* is Latin for "narrow" which refers to the strongly curved, narrow peritreme.

Female

Gnathosoma. Greatest width at base, 79; length to base of palpal trochanter, 72. All setae nude. Cheliceral digits 47 long from base of moveable digit, moderate in thickness, lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 270; II, 248; III, 242; IV, 345. Width of genua: I and II, 50; III, 40; IV, 39. Tarsus II has apical claws of medium size and slightly curved. Coxa I has two subequal setae, 20 to 25 long. Coxa II has two spurs: usual anterocaudal spur sharply pointed, about 25 long; inner spur sharply pointed, 18 long and 13 wide. Coxa III has two spurs: outer posterior one sharply pointed, 10 long and 5 wide; inner spur sharply pointed, 23 long and 14 wide. Coxa IV has minute, sharply pointed spur on posterocaudal border; at the base of the spur, coxal border forms a small, somewhat conspicuous, rounded prominence.

Dorsal plate. Covers most of dorsum; sides almost parallel, slightly concave for two-thirds length; tapers to blunt tip; 519 long; greatest width 281; has distinct light border; has 25 pairs of delicate setae, those on periphery and posterior tip of plate largest: medial setae 13, peripheral setae 18, terminal setae 28.

Sternal plate. Slightly more than five times as wide as long (width measured between outer edges of third sternal setae); anterior border slightly convex; posterior border concave, invaginated to level of median sternal setae; lateral margins straight; anterior corners bluntly pointed, extend between coxae I and II; posterior corners sharply pointed, extend laterally between coxae II and III. Has three pairs of

subequal setae, 30 long; distance between posterior pair two and one-third times as great as distance between first pair; first pair setae on anterior edge of plate, second pair set in from sides, third pair in extreme posterior corners.

Genitoventral plate. Width 80 (measured between outer edges of genitoventral setae); length 107 (from anterior edge of genitoventral seta to posterior tip of plate); moderately rounded; has prominent internal ridges; has distinct light border; setae 23 long, situated at level near posterior edge of coxa IV.

Anal plate. Suboval, sides and anterior edge broadly rounded; tapers to blunt tip. Crib um 20 long. Length 68 (from base of postanal seta to anterior edge of plate); greatest width 65; has distinct border effect of about same density as plate proper, separated on anterior half of plate by dark line. Adanal and postanal setae subequal, 25 to 30 long; adanal setae situated at level slightly posterior to middle of anus.

Unsclerotized part of venter. Has 12 or 13 pairs of setae between level of genitoventral setae and posterior end of anal plate, not counting peripheral setae; setae nearest genitoventral plate shortest, 23 long, distal ones longest, 33 long.

Peritreme. Sinuous and strongly curved, narrow, ends at mid-coxa I.

Hirstionyssus femuralis Allred, 1957

Figs. 22, 71, 135, 190, 232, 288, 332, 357, 448, 471, 490, 491, 499, 517, 526, 540, 554, 612

Distribution. UTAH: Juab Co.: *Neotoma lepida* (Howell, Allred, and Beck, 1957). Tooele Co.: *N. lepida* (Allred and Roseoe, 1957). Washington Co.: *Peromyscus* (probably) *eremicus* (Allred, 1957c).

Other Utah records. Iron Co.: *Mustella frenata.* Juab Co.: *Thomomys bottae, Thomomys talpoides.* Kane Co.: *T. bottae.* Salt Lake Co.: *Citellus armatus.* San Juan Co.: *T. bottae.* Sanpete Co.: *T. talpoides.* Utah Co.: *T. bottae.* Washington Co.: *T. bottae.*

Seasonal occurrence. Five males, 26 females and nine deutonymphs were taken. Males were found in April, October and December; females from April through December, except in June and October; and deutonymphs in April, September, October and December. Greatest numbers were taken in April and December .

Comments. Mites of *H. femuralis* were found most commonly in the Great Basin. They are known from nine counties.

This species apparently prefers pocket gophers of the genus *Thomomys* as its host.

In seven of its 11 collections, *H. femuralis* was the only mite on its host. In four collections it was associated with *Haemolaelaps* spp.

Hirstionyssus longichelae, new species

Figs. 23, 126, 234, 290, 447, 473, 567, 613

Utah records. Duchesne Co.: *Thomomys talpoides,* Timber Canyon, Strawberry River, two females, August, 1957. Summit Co.: *Ochotona princeps,* Bald Mtn., one female, August, 1957; *T. talpoides,* same locality, one female, August 1957. Utah Co.: *T. talpoides,* Palmyra Forest Camp, Diamond Fork Canyon, 14 females, June, 1951; Provo Canyon, one female, July, 1956.

Type data. Holotype female, B.Y.U. collection no. 926. Taken from *Thomomys* sp., Palmyra Forest Camp, Diamond Fork Canyon, Utah Co., Utah, 26 June 1951, by Dorald M. Allred. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *longichelae* refers to the very long digits of the chelicerae.

Female

Gnathosoma. Greatest width at base, 84; length to base of palpal trochanter, 70. All setae nude. Cheliceral digits long and slender, 108 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 245; II and III, 221; IV, 258. Width of genua: I and II, 50; III and IV, 36. Tarsus II has pair of apical, slightly curved spurs, 5 long. Coxa I has usual two setae of equal size. Coxa II has three spurs: usual anterocaudal one long, narrow and acutely pointed; posterocaudal one bluntly pointed, 10 long and 14 wide; inner spur broadly rounded, 19 long and 17 wide. Coxa III has two spurs: outer posterior one bluntly pointed, 7 long and 7 wide; inner posterior one broadly rounded, almost truncate at tip, 24 long and 19 wide. Coxa IV lacks spur.

Dorsal plate. Anterolateral margins slightly concave; medial and posterior margins straight or slightly convex; tapers to broad, blunt point; 452 long; greatest width 254. Has 26 pairs of setae; most anterior pair 10 long, anteromedial setae 19 long, medial setae 10 long, posterior ones 24 long.

Sternal plate. One and nine-tenths as wide as long (width measured between outer edges of third sternal setae); anterior and posterior borders slightly sinuous but generally convex; posterior margin at level behind third pair of setae; lateral margins moderately concave; an-

terior corners bluntly pointed; posterior corners rounded, not extended. Has three pairs of subequal setae; distance between posterior pair of setae 2.4 times as great as distance between first pair; first pair of setae set back from anterior margin of plate, third pair at extreme posterior corners, second pair set in from lateral margins.

Genitoventral plate. Width 84 (measured at outer edges of genitoventral setae); length 86 (from anterior edge of genitoventral seta to posterior border of plate); lacks conspicuous internal ridges; has light border effect; lightly punctate. Setae 22 long, situated at level of posterior edge of coxa IV.

Anal plate. Elongate oval; evenly convex, but more strongly tapered posteriorly. Has cribum. Length 62 (from base of postanal seta to anterior edge of plate); greatest width 22; has light border completely encircling plate; lightly punctate. Adanal setae and postanal seta subequal, about 17 long; adanal setae situated opposite middle of anus.

Unsclerotized part of venter. Has 10 pairs of setae posterior to genitoventral setae (not counting those on borders); all setae about equal, 22 long.

Peritreme. Slightly sinuous; ends at middle of coxa I; granulo-punctations faintly distinct only for half of width and length; very narrow, less than 2.5 wide for entire length.

Hirstionyssus thomomys, new species

Figs. 24, 70, 80, 133, 188, 230, 289, 336, 360, 446, 465, 494, 506, 507, 518, 527, 576, 614

Utah records. San Juan Co.: *Thomomys talpoides*, Kigalia Ranger Station, one male, June, 1955. Summit Co.: *T. talpoides*, Bald Mtn., four females, eight deutonymphs, August, 1957. Utah Co.: *T. talpoides*, Provo Canyon, one female, July, 1956.

Type data. Holotype female, B.Y.U. collection no. 4218. Taken from *Thomomys talpoides*, East of Bald Mtn., Summit Co., Utah, 8 August 1957, by Dorald M. Allred and Merlin Killpack. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Allotype male, B.Y.U. collection no. 4020. Taken from *Thomomys talpoides*, Kigalia Ranger Station, San Juan Co., Utah, 9 June 1955, by D Elden Beck. Same depository as holotype. The trivial name *thomomys* refers to the generic name of the host from which the holotype was taken.

Female

Gnathosoma. Greatest width at base, 94; length to base of palpal trochanter, 70. All setae nude. Cheliceral digits slender, 74 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 281; II, 238; III, 265; IV, 359. Width of genua: I and II, 58; III and IV, 46. Tarsus II has pair of apical, slightly curved spurs, 7 to 9 long. Coxa I has usual two setae, proximal one larger. Coxa II has three spurs: usual anterocaudal one long, narrow, acutely pointed; posterocaudal one bluntly pointed, 12 long and 14 wide; inner spur bluntly pointed, 17 long and 16 wide. Coxa III has two spurs: outer posterior one bluntly pointed, 11 long and 7 wide; inner posterior one sharply pointed, 22 long and 16 wide. Coxa IV lacks spur.

Dorsal plate. Anterolateral and posterolateral margins concave; mediolateral sides straight or slightly convex; tapers to blunt point; 507 long; greatest width 261; moderately punctate. Has 26 pairs of setae, posterior pair having one or both setae off plate; most anterior pair 14 long, anteromedial setae 39 to 41 long, medial setae 36 long, posterior setae 39.

Sternal plate. Two and one-half times as wide as long (width measured between outer edges of third sternal setae); anterior and posterior borders slightly sinuous; posterior border invaginated only to level of third pair of setae; lateral borders strongly concave; anterior corners bluntly pointed; posterior corners narrowly extend along anterior edges of coxae III. Has three pairs of subequal setae, third pair only slightly shorter than first and second; distance between posterior pair of setae 2.4 times as great as distance between first pair; first pair of setae on extreme anterior edge of plate, third pair on extreme posterior edge, second pair set in from lateral margins.

Genitoventral plate. Width 101 (measured at outer edges of genitoventral setae); length 108 (from anterior edge of genitoventral seta to posterior border of plate); lacks internal ridges; has light border effect; lightly punctate. Setae 41 long, situated at level of mid-coxa IV.

Anal plate. Elongate oval; evenly convex but more strongly tapered posteriorly. Has cribum. Length 70 (from base of postanal seta to anterior edge of plate); greatest width 60; has light anterior and lateral border; moderately punctate. Adanal setae 29 long, slightly longer

than postanal seta, situated opposite middle of anus.

Unsclerotized part of venter. Has 13 pairs of setae posterior to genitoventral setae (not counting those on borders); anterior setae 41 long, posterior setae 36.

Peritreme. Slightly sinuous; ends at anterior fourth of coxa I; granulo-punctate for entire width and length; 7 wide at level of coxa III, 5 wide for remaining length.

Male

Gnathosoma. Greatest width at base, 82; length to base of palpal trochanter, 58. All setae nude. Cheliceral digits 72 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 254; II, 199; III, 228; IV, 329. Width of genua: I, 50; II, 60; III and IV, 53. Tarsus II has pair of apical claws. Coxa I has two setae: basal one 25 long, distal one 16 long. Coxa II has three spurs: anterocaudal one approximately 17 long, narrow, sharply pointed; inner medial spur short and bluntly pointed, 7 long and 9 wide; posterocaudal spur represented only by slight, bluntly pointed bulge. Coxa III has two spurs: outer posterior one sharply pointed, 13 long and 7 wide; medial one sharply pointed, 18 long and 18 wide. Coxa IV has posterior spur, sharply pointed, 11 long and 5 wide.

Dorsal plate. Almost oval; tapers posteriorly to blunt tip; covers most of dorsal surface of body; 468 long; greatest width 254. Has 29 or 30 pairs of setae; some anterior and anterolateral setae largest, 25 to 30 long; other setae smaller, 19 to 22 long, subequal to setae on unsclerotized portion of body.

Holoventral plate. Three ventral plates usually fused into one; 335 long; 148 wide at level of coxa III. Has eight pairs of setae plus three anal setae, 22 to 36 long, posterior pairs longest.

Unsclerotized part of venter. Has eight or nine pairs of subequal setae anterior to posterior edge of holoventral plate, 36 long.

Peritreme. Narrow, slightly sinuous, extends to anterior fourth of coxa I.

Deutonymph

Gnathosoma. Greatest width at base, 77; length to base of palpal trochanter, 54. All setae nude. Cheliceral digits 77 long from base of moveable digit; slender; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 281; II, 242; III, 235; IV, 346. Width of genua: I, 50; II, 53; III, 46; IV, 48. Tarsus II lacks apical spurs. Coxa I has two subequal setae 25 long. Coxa II has three spurs: anterocaudal one angled, sharply pointed, 10 long and 7 wide; medial spur represented only by small, rounded knob; posterocaudal spur represented only by slight, bluntly pointed bulge. Coxa III has small, bluntly pointed spur, 5 long and 15 wide. Coxa IV lacks spur.

Dorsal plate. Elliptical; has slightly concave margins anterolaterally and posterolaterally; 305 long; greatest width 158. Has approximately 23 pairs of setae: anterior pair smallest, 11 long; posterior pair largest, 43 long; others subequal, 19 to 24 long.

Sterno-genitoventral plate. Ends at level opposite mid-coxa IV; length 132; greatest width at level of coxae II, 84. Has four pairs of setae: anterior pair largest, 41 long; posterior pair smallest, 22 long.

Anal plate. Length 43 (from base of postanal setae to anterior margin of plate); greatest width, 49. Cribum, 12 long. Anal setae subequal, 20 long; adanal setae situated slightly anterior of mid-anal position.

Unsclerotized part of venter. Has 15 to 18 pairs of subequal setae, 17 long.

Peritreme. Narrow, sinuous, extends to anterior third of coxa II.

Hirstionyssus torus, new species

Figs. 25, 76, 134, 185, 235, 291, 335, 356, 445, 474, 487, 492, 504, 512, 520, 529, 571

Utah records. San Juan Co.: *Sciurus aberti*, Devil's Canyon, nine miles north of Blanding, six males, 23 females (two with an egg), seven deutonymphs, May, 1951.

Type data. Holotype female, B.Y.U. collection no. 727. Taken from *Sciurus aberti*, 9 mi north of Blanding, San Juan Co., Utah, 6 May 1951, by Dorald M. Allred and D Elden Beck. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Allotype male, same data and depository as holotype. The trivial name *torus* is Latin for "protuberance," which refers to the coxa II spur which is represented only by a small hump.

Female

Gnathosoma. Greatest width at base, 80; length to base of palpal trochanter, 72. All setae

nude. Cheliceral digits 72 long from base of moveable digit; moderate in thickness; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 293; II, 230; III, 243; IV, 303. Width of genua: I, 43; II, 45; III and IV, 35. Tarsus II lacks apical spurs. Coxa I has two subequal setae, 23 long. Coxa II has two spurs: usual anterocaudal one approximately 20 long, sharply pointed; inner spur represented by rounded, slightly raised hump. Coxa III has two spurs: outer posterior one narrow, sharply pointed, 13 long and 5 wide; inner posterior one wider, sharply pointed, 15 long and 11 wide. Coxa IV has spur, 7 long and 5 wide.

Dorsal plate. Elliptical, with slightly curved sides; tapers gradually to blunt tip posteriorly; 532 long; greatest width 160. Has 25 or 26 pairs of delicate setae; those around periphery of plate largest, 13 to 18 long, except two terminal pairs which are 21 to 23 long; medial setae less than 8 long except for anteromedial pairs which are 13 long.

Sternal plate. Four and one-third times as wide as long (width measured between outer edges of third sternal setae); anterior border slightly convex; posterior border concave, invaginated almost to level of median sternal setae; lateral margins strongly concave, with thickened borders; anterior corners bluntly pointed, extend between coxae I and II; posterior corners sharply pointed, extend laterally between coxae II and III. Has three pairs of setae: anterior two pairs 28 long, posterior pair 30 long; distance between posterior pair of setae slightly more than three times distance between anterior pair; first pair of setae on anterior edge of plate, second pair set in from lateral edges, third pair in extreme corners of plate.

Genitoventral plate. Width 95 (measured between outer edges of genitoventral setae); length 125 (from anterior edge of genitoventral setae to posterior border of plate); has prominent internal ridges; has distinct light border which is evident almost whole distance along sides and posterior edge of plate; setae 23 long, situated at level opposite middle of coxa IV.

Anal plate. Oval, somewhat evenly convex; tapers posteriorly to blunt tip. Has distinct large cribum, 20 long. Length 74 (from base of postanal seta to anterior edge of plate); greatest width 67; has distinct darkened border; adanal and postanal setae subequal, 23 long; adanal setae situated opposite middle of anus.

Unsclerotized part of venter. Has 11 or 12 pairs of setae between level of genitoventral setae and posterior end of anal plate, not counting peripheral setae; setae subequal, 23 to 25 long.

Peritreme. Slightly sinuous, narrow, extends to middle of coxa I.

Male

Gnathosoma. Greatest width at base, 38; length to base of palpal trochanter, 46. All setae nude. Cheliceral digits 69 long from base of moveable digit; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus:I, 247; II, 206; III, 213; IV, 300. Width of genua: I, 38; II, 41; III and IV, 34. Tarsus II has pair of apical spurs. Coxa I has two normal setae: basal one 19 long, distal one 11 long. Coxa II has two spurs: anterocaudal one approximately 22 long, sharply pointed; ventromedial spur represented by rounded, slightly raised hump. Coxa III has two spurs: outer posterior one narrow and sharply pointed, 12 long and 4 wide; inner posterior one wider and sharply pointed, 11 long and 10 wide. Coxa IV has long, narrow spur, 13 long and 5 wide.

Dorsal plate. Elliptical; has slightly curved sides that taper gradually to blunt tip posteriorly; 417 long; greatest width 250. Has approximately 25 pairs of setae; anterolateral setae and terminal two pairs about equal in size to setae on unsclerotized portion of body, 22 to 33 long; posterolateral and medial setae tiny, about 5 long.

Holoventral plate. Sternal, genitoventral and anal plates fused into one; 324 long; 117 wide at level of coxa III. Has seven pairs of setae, plus three anal setae, 13 to 22 long, posterior ones longest.

Unsclerotized part of venter. Has seven pairs of subequal setae anterior to posterior edge of holoventral plate, 29 long.

Peritreme. Narrow, slightly sinuous, extends to middle of coxa I.

Deutonymph

Gnathosoma. Greatest width at base, 58; length to base of palpal trochanter, 53. All setae nude. Cheliceral digits 54 long from base of moveable digit; moderate in thickness; lack teeth.

Legs. Length from distal edge of coxa to base of pretarsus: I, 171; II, 164; III, 182; IV, 235. Width of genua: I, 36; II, 38; III and IV, 35. Tarsus II lacks apical spurs. Coxa I has two subequal setae, 14 long. Coxa II has two spurs:

usual anterocaudal one approximately 10 long, sharply pointed; inner spur represented by small, rounded protuberance. Coxa III has inner, posterior spur, 6 long and 7 wide. Coxa IV lacks spur.

Dorsal plate. Elliptical; has slightly curved sides that taper gradually to blunt tip posteriorly; 326 long; greatest width 185. Has approximately 23 pairs of setae: anterior and anterolateral ones subequal to those on unsclerotized portion of body, 7 to 11 long; terminal pair 36 long, others tiny, 5 long.

Sterno-genitoventral plate. Ends at level with posterior borders of coxa IV; length 158; greatest width at level of coxa II, 79. Has four pairs of subequal setae, 12 to 16, anterior pairs longest.

Anal plate. Length 55 (from base of postanal seta to anterior edge of plate); greatest width 40; has slightly darkened border. Cribum 8 long. Adanal setae 16 long, situated slightly anterior of mid-anal position; postanal seta 13 long.

Unsclerotized part of venter. Has 12 or 13 pairs of subequal setae, 12 long.

Peritreme. Narrow, slightly sinuous, extends to anterior edge of coxa II.

Hirstionyssus neotomae
(Eads and Hightower), 1951

Figs. 26, 77, 81, 82, 136, 181, 236, 237, 292, 331, 358, 361, 363, 444, 475, 488, 493, 498, 500, 502, 503, 505, 510, 513, 514, 523, 528, 570

In the Utah series there are two distinct forms. In one the sternal, dorsal and holoventral plates are smaller than in the other. Occasionally there is an extra pair of setae on the genitoventral pate of the female in both forms.

Distribution. ? locality from *Neotoma albigula, Neotoma fuscipes, Neotoma micropus* (Strandtmann and Wharton, 1958). NEVADA: *Neotoma lepida* (Allred and Goates, 1964b). TEXAS: *Liomys* sp., *N. micropus, Perognathus hispidus* (Eads and Hightower, 1951; Eads Trevino and Campos, 1965).

Utah records. Carbon Co.:*Thomomys talpoides*. Daggett Co.: *Neotoma cinerea*. Duchesne Co.: *N. cinerea*. Juab Co.: *Perognathus parvus*. Kane Co.: *N. lepida, P. parvus, Peromyscus maniculatus, Peromyscus truei*. San Juan Co.: *Dipodomys ordii, P. truei*.

Seasonal occurrence. Twenty males, 109 females, four protonymphs and 11 deutonymphs were collected from May through August. Greatest numbers were taken in June; only 11 were taken in other months. Males were found in June and July, females each month, and nymphs only in June.

Comments. Mites of *H. neotomae* are known from northern and southern Utah, but were taken more commonly from the Upper Colorado River Basin. They are known from six counties.

This mite apparently prefers wood rats (*Neotoma* spp.) as its hosts, although it has commonly been found on *Peromyscus* spp.

In four of 28 collections *H. neotomae* was the only mite found on its host. In 10 collections it was associated with other species of *Hirstionyssus*.

Hirstionyssus bisetosus Allred, 1957

Figs. 36, 68, 137, 184, 239, 299, 338, 366, 443, 466, 496, 509, 511, 519, 535, 566

Distribution. NEVADA:*Neotoma lepida* (Allred and Goates, 1964b). UTAH: Tooele Co.: *N. lepida* (Allred, 1957a).

Other Utah records. None.

Comments. This species likely is an inhabitant of the nests of wood rats. It is seldom found on the body of its host.

Hirstionyssus isabellinus
(Oudemans), 1913

Figs. 34, 91, 138, 183, 240, 295, 339, 441, 476, 521, 525, 574

Distribution. ? locality from variety of rodents (Strandtmann and Wharton, 1958). CALIFORNIA: *Microtus* sp. (Jameson and Brennan, 1957). OREGON: *Microtus longicaudus, Microtus montanus, Scapanus* sp., *Sorex vagrans* (Fonseca, 1948; Hansen, 1964). UTAH: Garfield Co.: *Peromyscus maniculatus* (Allred, 1957c). Tooele Co.: ? host (Woodbury, 1956a).

Other Utah records. Carbon Co.: *M. longicaudus, Thomomys talpoides*. Kane Co.: *P. maniculatus*. Morgan Co.: *Microtus* sp. Rich Co.: *Citellus armatus*. San Juan Co.: *M. longicaudus*. Summit Co.: *M. longicaudus, Ochotona princeps, Phenacomys intermedius*. Utah Co.: *Eutamias quadrivittatus, M. montanus, Microtus pennsylvanicus, Reithrodontomys megalotis, T. talpoides*. Washington Co.: *Onychomys torridus*.

Seasonal occurrence. One male, 40 females, one protonymph and five deutonymphs were taken from April through August and in February. A gravid female containing a larva was taken in August. The protonymph was collected in June, and the deutonymphs in May, July and August.

Comments. Mites of *H. isabellinus* are distributed over the state in 10 counties.

This species apparently prefers voles of the genus *Microtus*.

In three of 17 collections *H. isabellinus* was the only mite on its host. In four collections it was associated with other *Hirstionyssus* spp. In eight collections it was associated with *Laelaps* spp. which are commonly found on voles.

Hirstionyssus triacanthus
(Jameson), 1950

Figs. 38, 141, 241, 296, 442, 477, 569

Distribution. NEVADA: *Dipodomys merriami, Dipodomys microps, Onychomys torridus* (Jameson, 1950b; Allred, 1962; Goates, 1963). OREGON: *Dipodomys* sp. (Jameson, 1950b). TEXAS: *Dipodomys ordii* (Eads, Menzies and Miles, 1952). UTAH: Tooele Co.: *Ammospermophilus leucurus* (Woodbury, 1956b); *D. microps, D. ordii* (Keegan, 1953); *Lepus californicus, Perognathus formosus, Peromyscus maniculatus, Reithrodontomys megalotis* (Woodbury, 1956b). Utah Co.: *Citellus leucurus, D. microps, D. ordii, P. maniculatus, R. megalotis* (Elzinga, 1960).

Other Utah records. Beaver Co.: *D. ordii.* Box Elder Co.: *D. microps, D. ordii, P. maniculatus.* Daggett Co.: *D. ordii.* Duchesne Co.: *D. ordii.* Emery Co.: *D. ordii, Peromyscus crinitus.* Juab Co.: *D. microps, D. ordii, P. maniculatus.* Kane Co.: *D. ordii, Perognathus longimembris.* Millard Co.: *D. microps, D. ordii.* San Juan Co.: *D. ordii.* Sanpete Co.: *D. microps, D. ordii, Neotoma lepida.* Uintah Co.: *D. ordii.* Utah Co.: *Rattus norvegicus.* Washington Co.: *Dipodomys merriami, D. microps, D. ordii, Peromyscus cremicus.*

Seasonal occurrence. The 389 females were collected every month except November, mostly in June. Each of two females in July, three in August and two in October contained an egg.

Comments. Mites of *H. triacanthus* are known from 14 counties.

Although known from a variety of hosts, this species apparently prefers kangaroo rats, especially *D. microps*, as its hosts. The parasite index was five to eight on kangaroo rats and only one or two on other hosts.

In 19 of 75 collections, *H. triacanthus* was the only mite on its host. In 40 collections it was associated with *Hirstionyssus incomptus.*

The frequent occurrence of *H. incomptus* with *triacanthus* is unusual. In the collections of *incomptus*, more than 17% of the adults are males, whereas not a single male *triacanthus* was taken. As far as is known, the male of *triacanthus* has never been described or even found. These data lead us to suspect that *triacanthus* is a morphological variant of *incomptus*, representing either autogamous or thelytokous parthenogenesis.

Hirstionyssus hilli (Jameson), 1950

Figs. 33, 41, 139, 140, 242, 244, 297, 298, 439, 440, 478, 480, 568, 573

One specimen from *Perognathus parvus* varies from typical *H. hilli* in the shape and dimension of the ventral plates, dorsal plate, peritreme, and coxae II and III. Although this may represent a new species, it is retained here for the present.

Distribution. CALIFORNIA: *Perognathus parvus;* KANSAS: *Perognathus hispidus* (Jameson, 1950b). NEVADA: *P. parvus, Perognathus formosus* (Allred, 1963). UTAH: Kane Co.: *Peromyscus maniculatus;* Sevier Co.: *P. maniculatus* (Allred, 1957c). Tooele Co.: *Dipodomys ordii, Neotoma lepida* (Keegan, 1953); *Onychomys leucogaster* (Ho, 1962); *P. maniculatus* (Keegan, 1953). Utah Co.: *D. ordii, O. leucogaster, P. maniculatus* (Elzinga, 1960). Washington Co.: *Peromyscus eremicus* (Allred, 1957e).

Other Utah records. Carbon Co.: *P. parvus.* Juab Co.: *P. parvus.* Kane Co.: *O. leucogaster, P. parvus.* San Juan Co.: *Perognathus flavus.* Utah Co.: *P. parvus.* Washington Co.: *Perognathus longimembris.* Wayne Co.: *Perognathus* sp.

Seasonal occurrence. Two females were taken in April, one in May, 22 in June and one in October. One male and one deutonymph were taken in June. Each of three females in June contained an egg.

Comments. Apparently this mite prefers species of *Perognathus* as its host.

Hirstionyssus incomptus
(Eads and Hightower), 1952

Figs. 39, 92, 142, 186, 245, 293, 337, 364, 438, 481, 497, 508, 515, 522, 534, 575

Distribution. TEXAS: *Dipodomys ordii, Perognathus* sp. (Eads and Hightower, 1952). UTAH: Carbon Co.: *Peromyscus maniculatus;* San Juan Co.: *Peromyscus crinitus, P. maniculatus* (Allred, 1957c). Tooele Co.: *Ammospermophilus leucurus, Dipodomys microps, D. ordii* (Woodbury, 1956b); *Neotoma lepida* (Allred and Roscoe, 1957); *P. maniculatus, Reithrodontomys megalotis* (Ho, 1962). Utah Co.: *Citellus leucurus, D. ordii,* (Elzinga, 1960); *P. maniculatus, R. megalotis* (Ho, 1962).

Other Utah records. Box Elder Co.: *D. ordii.* Carbon Co.: *D. ordii.* Daggett Co.: *D. ordii.* Duchesne Co.: *D. ordii.* Emery Co.: *D. ordii.* Garfield Co.: *Microtus longicaudus.* Grand Co.: *Dipodomys* sp. Juab Co.: *D. microps, D. ordii, P. maniculatus.* Kane Co.: *D. ordii, Perognathus longimembris.* San Juan Co.: *D. ordii.* Sanpete Co.: *D. ordii.* Sevier Co.: *D. ordii.* Utah Co.: *D. microps, D. ordii, N. lepida, Rattus norvegicus.* Washington Co.: *Citellus variegatus, Dipodomys merriami, D. microps, D. ordii, Perognathus parvus, Peromyscus eremicus, R. megalotis.* Wayne Co.: *D. ordii, P. maniculatus.*

Seasonal occurrence. Totals of 96 males, 455 females and 53 deutonymphs were taken. Females were collected every month except November, mostly in April, May and June; males from February through October except in September, mostly in April and May; deutonymphs from March through July and in October, mostly in April and May. Gravid females were found, each with one egg, from February through August and in December, mainly in April and

May. Each of two females in April contained a larva.

Comments. Mites of *H. incomptus* are distributed over the state, although apparently they are more common in the southern part in the Upper Colorado River Basin. They are known from 16 counties.

This mite apparently prefers kangaroo rats as its hosts, especially *D. ordii*. On this host the mite population index was seven as compared to three or less for other hosts.

In 25 of 101 collections, *H. incomptus* was the only mite on its host. In 26 collections it was associated with *Haemolaelaps glasgowi*, and in 40 collections with *Hirstionyssus triacanthus*. The frequent occurrence of *H. incomptus* with *H. triacanthus* was significantly more common than between other mite species. It is unusual that two species of the same genus commonly occur on the same host with such a frequency.

Hirstionyssus bacoti

This species was listed by Elzinga (1960) from *Dipodomys microps* from Utah County and by Ho (1962) from *D. microps* and *Peromyscus maniculatus* from Tooele Co. No such species can be found listed in the literature. Perhaps their designations were meant to be *Ornithonyssus bacoti*.

Hirstionyssus carnifex (Koch), 1839

Distribution. ? localities from bats, *Clethrionomys* sp., *Mus* sp., *Peromyscus maniculatus, Rattus* sp., *Sorex* sp., and others (Strandtmann and Wharton, 1958). NEVADA: *Peromyscus crinitus* (Allred and Goates, 1964a). OREGON: House mouse; UTAH: Tooele Co.: *P. maniculatus* (Keegan, 1953). ? locality: *Citellus armatus* (Jenkins, 1965).

Other Utah records. None.

Comments. We believe that the Utah records of *H. carnifex* are misidentifications, and doubt that this species occurs in Utah, probably not even in the United States.

Hirstionyssus geomydis (Keegan), 1946

Distribution. COLORADO: *Geomys bursarius, Thomomys talpoides, Thomomys umbrinus* (Miller and Ward, 1960). KANSAS: *G. bursarius* (Keegan, 1946). UTAH: Tooele Co.: *Neotoma lepida* (Allred and Roscoe, 1957).

Other Utah records. None.

Comments. We believe the above records for Utah are misidentifications, and doubt that this species has been taken in Utah.

Hirstionyssus obsoletus Jameson, 1950

Distribution. CALIFORNIA: *Clethrionomys californicus, Neurotrichus gibbsii, Peromyscus maniculatus, Sorex trowbridgii* (Jameson, 1950a). OREGON: *P. maniculatus* (Hansen, 1964). UTAH: Piute Co.: *P. maniculatus* (Allred, 1957a).

Other Utah records. None.

Comments. We believe the above records for Utah are misidentifications, and doubt that this species has been taken in Utah.

Ichoronyssus robustipes (Ewing), 1925

Figs. 40, 83, 143, 171, 248, 300, 362, 412, 418, 536, 537, 572

Chiroptonyssus robustipes of authors.

Distribution. ARIZONA: Bats (Bradshaw and Ross, 1961). ? locality from bats (Strandtmann and Wharton, 1958).

Utah records. Washington Co.: *Tadarida mexicana*.

Seasonal occurrence. Three males and 16 females were taken in February.

KEY TO SPECIES OF FEMALE *Dermanyssus*

1. Two dorsal plates, posterior one small (Fig. 28) ..... *sanguineus*, page 32
   One dorsal plate (Fig. 27) 2

2. Dorsal plate rounded posteriorly, widest near middle (Fig. 27) ..... *hecki*, page 32
   Dorsal plate truncate posteriorly, widest near anterior end (Fig. 29) ..... *gallinae*, page 32

Dermanyssus sanguineus Hirst, 1914
Figs. 28, 144, 250, 301

Allodermanyssus sanguineus of authors (Krantz, 1959).

Distribution. ARIZONA, CONNECTICUT, ILLINOIS, INDIANA, MARYLAND, MASSACHUSETTS, NEW YORK, PENNSYLVANIA: domestic mice and rats (Pratt and Good, 1954). UTAH: Salt Lake Co.: *Rattus norvegicus* (Pratt, Lane and Harmston, 1949). Washington Co.: *Peromyscus eremicus* (Allred, 1957c). WASHINGTON, D.C.: ? host (Pratt, Lane and Harmston, 1949).

Other Utah records. None.

Dermanyssus hecki Allred, 1957
Figs. 27, 67, 84, 93, 101, 149, 174, 251, 308, 342, 345, 367, 389, 582

Distribution. NEVADA: *Neotoma lepida, Peromyscus crinitus* (Allred and Goates, 1964a, 1964b). UTAH: Box Elder Co.: *Peromyscus maniculatus;* Millard Co.: *P. crinitus;* San Juan Co.: *Peromyscus boylii, P. crinitus, P. maniculatus;* Washington Co.: *P. crinitus, Peromyscus eremicus, P. maniculatus;* Wayne Co.: *P. crinitus* (Allred, 1957c).

Other Utah records. Emery Co.: *P. crinitus.* Garfield Co.: *P. crinitus, P. maniculatus.* Grand Co.: *N. lepida.* Juab Co.: *N. lepida.* Kane Co.: *N. lepida, P. crinitus, P. maniculatus, Peromyscus truei.* San Juan Co.: *Eutamias quadrivittatus, Neotoma albigula, N. lepida, P. truei.* Sanpete Co.: *Marmota flaviventris.* Washington Co.: *Lepus californicus, N. lepida.* Wayne Co.: *P. maniculatus, P. truei.*

Seasonal occurrence. Eleven males, 14 females, 28 protonymphs and 29 deutonymphs were collected in February, May through September, and in December. Males were found in May, August and September; females from May through September and in December; protonymphs in February and from May through September; and deutonymphs in May, June, July, August and December.

Comments. Mites of *D. hecki* are most common in the southern part of Utah in the Upper Colorado River Basin. They are known from 11 counties.

This species apparently prefers wood rats (*Neotoma* spp.) and white-footed mice (*Peromyscus* spp.)

In 16 of 34 collections, *D. hecki* was the only mite on its host.

The mites reported by Keegan (1953), Woodbury (1956b), and Allred and Roscoe (1957) as *Dermanyssus* sp. from *N. lepida* and *P. crinitus* likely are *D. hecki.*

Dermanyssus gallinae
(DeGeer), 1778
Figs. 29, 145, 247, 302

Distribution. UTAH: Tooele Co.: *Neotoma lepida, Onychomys leucogaster, Peromyscus crinitus* (Ho, 1962). Utah Co.: *O. leucogaster* (Elzinga, 1960).

Other Utah records. None.

Comments. Mites of this species are usual parasites of birds, although mammals occasionally are attacked.

Steatonyssus antrozoi
Radovsky and Furman, 1963
Figs. 32, 35, 150, 253, 312, 421, 578

Distribution. ALABAMA, ARIZONA, CALIFORNIA, GEORGIA, ILLINOIS, NEW YORK, OKLAHOMA, OREGON, SOUTH CAROLINA, TEXAS: Various bats (Radovsky and Furman, 1963).

Utah records. San Juan Co.:*Corynorhinus rafinesque.*

Seasonal occurrence. Five females, each of three with an egg, were taken in May.

KEY TO SPECIES OF FEMALE *Ornithonyssus*

1. With two dorsal plates (Fig. 37) . . . . . *aridus*, page 33
   With one dorsal plate (Fig. 54) 2

2. Sternal plate with three pairs of setae (Fig. 254) . . . . . *bacoti*, page 33
   Sternal plate with two pairs of setae (Fig. 257) . . . . . *sylvianum*, page 33

KEY TO SPECIES OF MALE *Ornithonyssus*

1. Dorsal plate narrow, covers less than half of dorsal surface of body (Fig. 86) . . . . . *bacoti*, page 33
   Dorsal plate covers half or more of dorsal surface of body 2

2. Dorsal plate abruptly invaginated near posterior tip *sylviarum*

Dorsal plate evenly tapered posteriorly from about midpoint (Fig. 85) ..... *aridus*

Ornithonyssus aridus
Furman and Radovsky, 1963
Figs. 37, 85, 94, 152, 256, 314, 369, 401, 427, 539, 581

Distribution. CALIFORNIA, NEVADA: *Ammospermophilus leucurus;* UTAH: Washington Co.: *A. leucurus* (Furman and Radovsky, 1963).

Other Utah records. None.

Ornithonyssus bacoti (Hirst), 1913
Figs. 54, 86, 95, 146, 176, 254, 303, 346, 372, 587

Distribution. Southeastern United States: Domestic rats (Pratt and Good, 1954). ALABAMA: *Didelphis* sp., *Peromyscus nuttallii, Rattus norvegicus, Sigmodon* sp. (Hays and Guyton, 1958). MARYLAND: *Microtus pennsylvanicus, Peromyscus leucopus* (Drummond, 1957). OKLAHOMA: *Peromyscus* spp. (Ellis, 1960). TEXAS: *Didelphis* sp., *Liomys* sp., *Neotoma floridana, Mus musculus, Neotoma micropus, R. norvegicus, Sigmodon* sp. (Randolph and Eads, 1946; Eads, Menzies and Miles, 1952; Eads, Trevino and Campos, 1965). UTAH: Beaver Co.: *Peromyscus maniculatus;* Carbon Co.: *P. maniculatus;* Daggett Co.: *Peromyscus crinitus;* Duchesne Co.: *P. maniculatus, Peromyscus truei;* Emery Co.: *P. maniculatus;* Garfield Co.: *P. maniculatus;* Iron Co.: *Peromyscus eremicus* (Allred, 1957c). Juab Co.: *Neotoma lepida, P. maniculatus* (Allred, 1957c; Howell, Allred and Beck, 1957). Kane Co.: *P. maniculatus, P. truei;* Millard Co.: *P. maniculatus;* San Juan Co.: *Peromyscus boylii, P. maniculatus;* Sanpete Co.: *P. maniculatus* (Allred, 1957c). Tooele Co.: *Citellus townsendii* (Ho, 1962); *Eutamias minimus* (Woodbury, 1956b); *N. lepida* (Allred and Roscoe, 1957); *P. crinitus, P. maniculatus, P. truei* (Woodbury, 1956b). Uintah Co.: *P. maniculatus* (Allred, 1957c); Utah Co.: *C. townsendii, P. maniculatus* (Elzinga, 1960); *P. truei* (Allred, 1957c); *R. norvegicus* (Myklebust, 1951). Washington Co.: *P. eremicus, P. maniculatus* (Allred, 1957c).

Other Utah records. Beaver Co.: *Perognathus* sp. Daggett Co.: *P. maniculatus.* Duchesne Co.: *E. minimus.* Garfield Co.: *P. truei.* Juab Co.: *Perognathus parvus, P. truei.* Kane Co.: *P. parvus.* San Juan Co.: *Dipodomys ordii, P. crinitus, P. truei.*

Seasonal occurrence. Seventeen males, 56 females and 115 protonymphs were taken. Males were found in March, June and August; females in May, June, August, September and November; protonymphs from February through November, except in April and October.

Comments. Mites of *O. bacoti* are distributed over the state, although apparently they are more common in the southern parts in the Upper Colorado River Basin. They are known from 15 counties.

This species apparently prefers *P. truei* as its host. Its frequency of occurrence was greatest on *P. truei* and *R. norvegicus.* Population indices were three to four for *Peromyscus* spp., seven for *Rattus,* and one for other hosts.

In 24 of 56 collections, *O. bacoti* was the only mite on its host.

Ornithonyssus sylviarum
(Canestrini and Fanzago), 1877
Figs. 30, 31, 151, 257, 259, 304, 311, 386, 415, 577, 583

Some variations were noted in the Utah series. The Utah specimens have a small pair of penultimate setae on the dorsal plate contrary to Furman's and Radovsky's (1963) diagnosis of the genus. The third pair of sternal setae are off the plate more frequently than on. They vary in position from the edge of the plate to a considerable distance from it.

Distribution. ? locality, mostly birds; *Eutamias* sp., *Mus* sp. (Strandtmann and Wharton, 1958). MARYLAND: *Mus musculus* (Drummond, 1957). TEXAS: *Eptesicus fuscus, Myotis velifer* (George and Strandtmann, 1960).

Utah records. Beaver Co.: *Marmota flaviventris.* Utah Co.: *Sylvilagus nuttallii.*

Seasonal occurrence. One female was taken in April and five in June.

Comments. Principally a parasite of birds, *O. sylviarum* infrequently attacks other animals in its environs.

Laelaptidae Berlese, 1892

Most mites of this family are parasitic on both invertebrates and vertebrates. They are worldwide in distribution, and are commonly found on mammals.

KEY TO GENERA OF FEMALE LAELAPTIDAE

1. Femur II with large thumb-like spur (Fig. 541) ..... *Androlaelaps*

   Femur II lacks spur 2

2. Genitoventral plate with more than one pair of setae (Fig. 309) ..... *Laelaps*, page 35

   Genitoventral plate with only usual pair of setae (Fig. 313) 3

3. Body circular; legs I and II subequal; setae of sternal plate and coxae thick, almost spine-like (Fig. 271) ..... *Eubrachylaelaps*, page 37

   Body oval; leg I distinctly longer and thinner than II; setae of sternal plate and coxa moderately slender (Fig. 280) 4

4. Sternal plate about as long as wide, distance between first and third setae about same as between third pair (Fig. 277) ..... *Hypoaspis*, page 39

   Sternal plate wider than long, distance between first and third setae about half as great as between third pair (Fig. 280) ..... *Haemolaelaps*, page 39

KEY TO GENERA OF MALE LAELAPTIDAE

1. Dorsal setae expanded distally, blade-like (Fig. 424) ..... *Hypoaspis*, page 39

   Dorsal setae normal 2

2. Femur II with large spur (Fig. 541) ..... *Androlaelaps*

   Femur II lacks spur 3

3. Leg I more slender and much longer than leg II ..... *Haemolaelaps*, page 39

   Legs I and II subequal 4

4. Setae of holoventral plate thick, heavy, almost spine-like (Fig. 368) ..... *Laelaps*, page 35

   Setae of holoventral plate of normal dimensions (Fig. 365) ..... *Eubrachylaelaps*, page 37

Till (1963) considers *Haemolaelaps* as a synonym of *Androlaelaps*. However, for the present we recognize these as separate genera.

Androlaelaps leviculus Eads, 1951

Figs. 158, 260, 305, 541, 585

Hypoaspis leviculus of some authors.

Mites collected in this study vary slightly in size and morphology from the description of the type. In the Utah specimens there are one large and three or four small pairs of metapodal plates on the female. The peritreme ends at the anterior fourth of coxa I.

Distribution. NEVADA: *Onychomys torridus, Perognathus formosus, Perognathus longimembris, Peromyscus* sp. (Allred, 1962, 1963; Allred and Goates, 1964a). TEXAS: *O. leucogaster, Perognathus hispidus, Sigmodon hispidus* (Eads, 1951). UTAH: Box Elder Co.: *Peromyscus maniculatus* (Allred, 1958). Tooele Co.: *O. leucogaster, Perognathus parvus, Peromyscus crinitus, P. maniculatus* (Keegan, 1953). ? locality: *Citellus lateralis* (Jenkins, 1965).

Other Utah records. Beaver Co.: *Dipodomys* sp., *P. crinitus*. Box Elder Co.: *P. parvus*. Daggett Co.: *Dipodomys ordii*. Emery Co.: *P. maniculatus*. Iron Co.: *D. ordii*. Juab Co.: *P. formosus, P. parvus*. Kane Co.: *P. formosus*. San Juan Co.: *O. leucogaster, Perognathus apache*. Sanpete Co.: *Citellus armatus*. Uintah Co.: *Citellus lateralis*. Washington Co.: *Onychomys* sp., *P. parvus*.

Seasonal occurrence. The 47 females were taken from April through October. Greatest numbers were found in July and September.

Comments. Mites of *A. leviculus* apparently are more common in the southern part of Utah. They are known from 12 counties.

This mite apparently is more commonly associated with grasshopper mice (*Onychomys* spp.) and pocket mice (*Perognathus* spp.) than with other rodents.

In nine of 19 collections, *A. leviculus* was the only mite on its host.

It is unusual that this species has not been recorded from a wider geographic area. Furman (1954b) indicated that this and four other species have been taken in the Nearctic and Neotropical realms on rodents of the families Muridae, Cricetidae and Heteromyidae. Woodbury's (1956b) record of *Androlaelaps* sp. from *O. leucogaster* in Tooele County likely is *A. leviculus*.

KEY TO SPECIES OF FEMALE *Laelaps*

1. Posterior border of sternal plate invaginated to level at least midway between first and second pairs of sternal setae (Fig. 265) ..... *kochi*

   Posterior border of sternal plate almost straight, never invaginated beyond third pair of sternal setae (Fig. 263) 2

2. Adanal setae reaching almost to or beyond base of postanal seta (Fig. 159) 3

   Adanal setae very short, tips far from base of postanal seta (Fig. 153) ..... *multispinosus*

3. Genitoventral plate with slit-like invagination at level of usual pair of genitoventral setae, expanding abruptly immediately posterior to setae (Fig. 307) ..... *incilis*, page 36

   Genitoventral plate not as above (Fig. 315) ..... *nuttalli*, page 37

Laelaps kochi Oudemans, 1936

Figs. 55, 72, 96, 154, 172, 178, 189, 265, 309, 340, 347, 370, 531, 580

Distribution. ALABAMA: *Pitymys* sp. (Hays and Guyton, 1958). CALIFORNIA: *Microtus* sp. (Jameson and Brennan, 1957). DELAWARE: *Microtus pennsylvanicus* (Florschutz and Darsie, 1960). ILLINOIS: *Microtus coragaster* (Tipton, 1960). MARYLAND: *Blarina brevicauda*, *M. pennsylvanicus*, *Peromyscus leucopus*, *Pitymys pinetorum* (Drummond, 1957). NEW YORK: *Microtus chrotorrhinus*; PENNSYLVANIA: *Microtus* sp.; UTAH: Utah Co.: *Microtus montanus* (Tipton, 1960).

Other Utah records. Beaver Co.: *M. montanus*. Carbon Co.: *Microtus longicaudus*. Daggett Co.: *M. longicaudus*. Iron Co.: *Eutamias minimus*. Kane Co.: *Dipodomys ordii*. Rich Co.: *Microtus* sp. San Juan Co.: *M. longicaudus*. Sanpete Co.: *Microtus* sp. Sevier Co.: *D. ordii*. Summit Co.: *Phenacomys intermedius*. Utah Co.: *Eutamias quadrivittatus*, *M. pennsylvanicus*.

Seasonal occurrence. Totals of 34 males, 61 females, three protonymphs and 13 deutonymphs were taken. Males were found from March through June and in August and October, mostly in May and June; females from March through December except September, mainly in May and June; protonymphs in March, April and June; and deutonymphs in May, June and October. Each of two females in March, four in May, one in July and one in August contained a larva.

Comments. Mites of *L. kochi* are distributed over the state in 11 counties.

The preferred hosts of mites of this species apparently are voles (*Microtus* spp.)

In two of 25 collections, *L. kochi* was the only mite on its host. In four collections it was associated with another species of *Laelaps*.

Laelaps multispinosus Banks, 1909

Figs. 56, 175, 180, 263, 310, 343, 348, 368, 532, 588

Distribution. ALABAMA: *Ondatra* sp. (Hays and Guyton, 1958; Tipton, 1960). NEBRASKA: *Ondalia [sic.] zibethicus* (Rapp, 1962). NEW YORK: *Ondatra zibethica*; TEXAS: *Ondatra* sp. (Tipton, 1960). UTAH: Salt Lake Co.: *Peromyscus maniculatus* (Allred, 1957d); Utah Co.: *O. zibethica* (Tipton, 1960).

Other Utah records. Summit Co.: *O. zibethica*.

Seasonal occurrence. Totals of 59 males, 218 females, 29 protonymphs and 44 deutonymphs were taken. Males were taken in January, February, October and December; females the same months; protonymphs in February and December; and deutonymphs in January, February and December. Each of 18 females in January, seven in February and six in December contained an egg. Each of 25 in January and three in February contained a larva. The developing deutonymphal integument is visible in six protonymphs in February, and the adult integument in eight deutonymphs in January and February.

Comments. Mites of this species likely are found wherever their preferred host, the muskrat (*O. zibethica*) occurs. They are known in Utah from only two counties.

In all eight collections this mite was the only species found on its host.

Laelaps incilis, new species

Figs. 61, 155, 266, 307, 533, 579

Utah records. Beaver Co.: *Microtus montanus,* Delano Ranger Station, five females, June, 1957; *Peromyscus maniculatus,* same locality and date, five females. Carbon Co.: *Microtus longicaudus,* three miles south of Scofield, one female, July, 1960. Emery Co.: *Microtus* sp., six miles north of Huntington, one female, July, 1959. Rich Co.: *Microtus* sp., Laketown, nine females, August, 1952. Utah Co.: *Eutamias quadrivittatus,* Provo, one female, October, 1956.

Comments. In one of nine collections, *L. incilis* was the only mite on its host. In five collections it was associated with *Laelaps kochi.*

Type data. Holotype female, B.Y.U. collection no. 4777. Taken from *Eutamias quadrivittatus,* Rock Canyon, Utah Co., Utah, 19 October 1956, by R. Kent Utley. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *incilis* is Latin for "cut in," which refers to the slit-like invaginations of the genitoventral plate.

Female

Gnathosoma. Greatest width at base, 105; length to base of palpal trochanter, 95. All setae nude. Three pairs of ventral setae on base of gnathosoma: anteroexternal pair shortest, 20 long; anteromedial pair longest, 50 long; posterior pair 27 long. Moveable digit of chelicera 30 long from base to tip, with two teeth and terminal hooked tip; fixed digit slightly shorter than moveable one, with one tooth and slightly hooked tip, and modified seta.

Idiosoma. 699 long, 545 wide.

Legs. Length from distal edge of coxa to base of pretarsus: I, 300; II, 285; III, 270; IV, 460. Width of genua: I, 57; II, 62; III, 50; IV, 42. Elongate setae of femora I and II of moderate length, approximately 63 long. Coxa I has inner, distal blunt spine 38 long, and inner proximal seta 48 long. Coxa II has inner blunt spine 43 long. Coxa III has inner blunt spine 33 long. Coxa IV has smaller, more pointed spine 28 long.

Dorsal plate. Elliptical; covers most of idiosoma except small part of lateral and posterior parts; 616 long and 431 wide. Has 37 pairs of setae, those anteromedially smaller than ones laterally and posteriorly; setae at level of sternal plate, 32 long; at posterior level of genitoventral plate, 55 to 60 long; mediopenultimate pair 42 long; terminal pair 113 long.

Sternal plate. Length 102; width 167; ratio 1:1.7 (width measured between outer edge of third sternal setae); anterior border slightly convex; posterior border with abrupt invagination to level of third pair of setae. Has three pairs of subequal setae: anterior pair 93 long, reach almost to posterior border of plate; medial and posterior pairs 98 long; distance between anterior pair, 75; between median pair, 145; between posterior pair, 155. Has two pairs of slit-like pores: anterior pair immediately behind first pair of setae, slightly angled, with outer end situated more anteriorly; posterior pair midway between second and third setae, almost parallel with transverse axis of plate.

Genitoventral plate. Width at point slightly behind usual genitoventral setae, 224; length from anterior edge of usual genitoventral setae to posterior border, 147. Edges of plate at level of usual genitoventral setae with narrow invagination which is present in some specimens only as distinct suture. Has usual pair of setae situated at level opposite posterior border of coxae IV, and three pairs of accessory setae along latero-posterior border of plate. Usual genitoventral setae 98 long, hardly reaching to bases of middle pair of accessory setae. Distance between usual genitoventral setae, 115; between third pair of accessory setae, 60. Length of accessory setae, 100.

Anal plate. Anterior and lateral edges slightly convex with evenly tapering sides except for point opposite anus which is slightly indented; length 125; width 107. Adanal setae 60 long, situated opposite posterior border of anus; post-

anal seta 100 long, almost twice as thick as adanal setae.

Unsclerotized part of venter. Has 19 pairs of setae including those on posterior border; those nearest genitoventral plate almost peg-like, 57 long; those more posteriorly longer and more slender; terminal pair longest, 125 long.

Peritreme. Slightly sinuous with abrupt curve at level of coxa II; extends to posterior edge of coxa I.

Comments. *Laelaps incilis* is similar in most respects to the *alaskensis*, *clethrionomydis* and *lemmi* complex. It may be separated from *alaskensis* on the basis of its 37 pairs of dorsal plate setae, the greater number of setae on the unsclerotized portion of the venter, the longer anal plate, and the placement of the adanal setae. It differs from *clethrionomydis* in the shape of the peritreme, its larger anal plate, and the longer adanal setae. It can be distinguished from *lemmi* on the basis of its smaller size, fewer number of dorsal plate setae, greater number of ventral setae, placement and length of the adanal setae, and lengths of postanal seta and peritreme.

Laelaps nuttalli Hirst, 1916

Figs. 90, 153, 159, 268, 315

Distribution. Southeastern United States from domestic rats (Pratt and Good, 1954). ALABAMA: *Rattus norvegicus*, *Rattus rattus* (Hays and Guyton, 1958). GEORGIA: ? host; TEXAS: Rat (Tipton, 1960). UTAH: Duchesne Co.: *Peromyscus maniculatus* (Allred, 1957d).

Other Utah records. None.

Comments. Lack of additional records suggests some doubt as to the validity of the above records from Utah.

KEY TO SPECIES OF FEMALE *Eubrachylaelaps*

1. Sternal plate twice as wide as long; first sternal setae not reaching posterior border of plate (Fig. 269) ..... *crowei*

   Sternal plate three or more times as wide as long; first sternal setae reaching almost to or beyond posterior border of plate (Fig. 271) 2

2. Postanal seta barely extending beyond apex of cribum; anterior edge of anal plate with two distinct humps (Fig. 160) ..... *hollisteri*, page 38

   Postanal seta extending for half or more of its length beyond apex of cribum; anterior edge of anal plate almost evenly convex (Fig. 163) 3

3. Unsclerotized portion of venter posterior to genitoventral plate with nine pairs of setae arranged in 4:4:1 sequence (Fig. 198); posterior border of sternal plate invaginated to level about midway between second and third sternal setae (Fig. 272) ..... *circularis*, page 38

   Unsclerotized portion of venter posterior to genitoventral plate with seven pairs of setae arranged in 3:4 sequence (Fig. 196); posterior border of sternal plate invaginated almost to level of second sternal setae (Fig. 275) ..... *debilis*, page 38

Eubrachylaelaps crowei Jameson, 1947

Figs. 62, 157, 195, 269, 306, 584

According to Furman (1955), there is considerable variation in the anal and sternal plates, and the anal and dorsal setae.

Distribution. COLORADO: *Onychomys leucogaster* (Furman, 1955). KANSAS: *O. leucogaster* (Jameson, 1947). OREGON: *Microtus montanus* (Hansen, 1964). TEXAS: *Dipodomys spectabilis*, *O. leucogaster* (Eads, Menzies and Miles, 1952). UTAH: San Juan Co.: *O. leucogaster* (Furman, 1955); Tooele Co.: *O. leucogaster* (Keegan, 1953).

Other Utah records. Grand Co.: *O. leucogaster*, *Perognathus* sp.

Seasonal occurrence. Eight females of *E. crowei* were collected in May and August, and three females taken in August were gravid.

Comments. The grasshopper mouse, *O. leucogaster*, apparently is the preferred host of this mite.

Eubrachylaelaps hollisteri
(Ewing), 1925
Figs. 60, 160, 197, 271, 320, 586

Distribution. CALIFORNIA: *Neotoma* sp., *Perognathus californicus, Peromyscus californicus, Peromyscus crinitus, Peromyscus maniculatus, Thomomys bottae* (Furman, 1955; Strandtmann and Wharton, 1958). NEVADA: *P. crinitus* (Allred and Goates, 1964a). UTAH: Beaver Co.: *P. crinitus, P. maniculatus, Peromyscus truei;* Box Elder Co.: *P. crinitus, P. maniculatus;* Emery Co.: *P. maniculatus;* Juab Co.: *P. truei;* Kane Co.: *P. crinitus, P. maniculatus* (Allred, 1958). Tooele Co.: *P. crinitus, P. maniculatus* (Woodbury, 1956b). Washington Co.: *Peromyscus eremicus* (Allred, 1958).

Other Utah records. Daggett Co.: *P. maniculatus.* Duchesne Co.: *P. crinitus, P. maniculatus.* Juab Co.: *Perognathus parvus.* Kane Co.: *Neotoma lepida, P. parvus.* San Juan Co.: *P. crinitus.* Sanpete Co.: *P. crinitus.* Sevier Co.: *P. maniculatus.*

Seasonal occurrence. The 158 female *E. hollisteri* were collected from April through August and in November and December. Greatest numbers were taken in June and August. Six females in June and seven in August each contained a larva. No males or immature stages were taken; they likely are nest dwellers.

Comments. Mites of *E. hollisteri* are equally distributed over Utah in the Great and Upper Colorado River basins in 12 counties.

This species is closely associated with the canyon mouse, *P. crinitus*. Eighty-four percent of its collections were from *Peromyscus* spp.—42% from *P. crinitus* and 36% from *P. maniculatus*.

In 14 of its 21 collections, *E. hollisteri* was the only mite on its host. It was associated with *Eubrachylaelaps circularis* in one collection.

Eubrachylaelaps circularis
(Ewing), 1933
Figs. 63, 87, 89, 97, 105, 164, 165, 177, 198, 272, 322, 341, 349, 365, 530, 589

Allred (1954a, 1957f) discussed some of the morphological variations of this species in Utah. Specimens of a northern distribution have a larger dorsal plate, fewer dorsal setae and better developed metapodal plates than those from southern Utah. Variations between specimens of northern and southern distribution were discussed by Furman (1955) with reference to the sternal and anal plates, and anal setae.

Distribution. ARIZONA. *Peromyscus* sp., CALIFORNIA: *Peromyscus boylii* (Jameson and Brennan, 1957); *Peromyscus californicus, Peromyscus maniculatus;* COLORADO: *Neotoma mexicana* (Furman, 1955). NEVADA: *Peromyscus truei* (Allred and Goates, 1964a). UTAH: Beaver Co.: *P. truei;* Daggett Co.: *P. maniculatus, P. truei;* Davis Co.: *P. maniculatus;* Duchesne Co.: *P. truei;* Grand Co.: *P. boylii* (Allred, 1958). Juab Co.: *Neotoma lepida* (Howell, Allred and Beck, 1957). Kane Co.: *P. boylii;* Piute Co.: *P. maniculatus, P. truei;* Salt Lake Co.: *P. boylii, P. maniculatus;* San Juan Co.: *P. boylii, Peromyscus crinitus, P. truei* (Allred, 1958). Sevier Co.: *P. truei* (Ewing, 1933). Tooele Co.: *P. truei* (Keegan, 1953); *P. maniculatus* (Allred, 1954a); *N. lepida* (Allred and Roscoe, 1957). Utah Co.: *P. boylii, P. crinitus, P. maniculatus, P. truei;* Washington Co.: *Peromyscus eremicus, P. maniculatus* (Allred, 1954a).

Other Utah records. Duchesne Co.: *P. maniculatus.* Emery Co.: *P. truei.* Garfield Co.: *P. maniculatus, P. truei.* Juab Co.: *Sylvilagus audubonii.* Kane Co.: *P. maniculatus, P. truei.* San Juan Co.: *P. maniculatus.* Sanpete Co.: *P. crinitus.* Tooele Co.: *Perognathus parvus.* Washington Co.: *Lepus californicus, N. lepida, Perognathus longimembris, P. crinitus.* Wayne Co.: *P. maniculatus, P. truei.*

Seasonal occurrence. A total of 620 females was taken. Mites were collected every month except September and December. Gravid females were found every month except March, July, September and December. Apparently this species reproduces all year round, although the principal periods are June and August. Males and immature stages were not taken. These likely are nest dwellers as suggested by Allred (1957f).

Comments. Mites of *E. circularis* are more common in southern than in northern Utah. They were found about equally in the Upper Colorado River and Great basins, and are known from 18 counties.

This species is most closely associated with the Pinyon Mouse (*P. truei*) which accounts for its more southerly distribution. Its association with *P. maniculatus* likely accounts for its northerly extension of range. Ninety-three percent of its collections were from *Peromyscus* spp.—48% from *P. truei* and 33% from *P. maniculatus*.

In 32 of its 78 collections, *E. circularis* was the only mite found on its host. In three collections it was found with *Eubrachylaelaps debilis*.

Eubrachylaelaps debilis
Jameson, 1950
Figs. 64, 163, 196, 275, 321, 590

Furman (1955) pointed out intraspecific variation in the sternal and anal plates, second pair of sternal pores, and anal and dorsal setae. Occasionally the anterior pair of sternal setae are not on the plate.

Distribution. CALIFORNIA: *Microtus longicaudus, Peromyscus maniculatus* (Keegan, 1953; Furman, 1955). NEVADA: *Peromyscus crinitus, Peromyscus truei* (Allred and Goates, 1964a). OREGON: *P. maniculatus* (Keegan, 1953). UTAH: All counties except Box Elder, Cache, Davis, Kane, Morgan, Salt

Lake and Weber: *P. maniculatus;* Iron Co.: *Peromyscus eremicus;* San Juan Co.: *P. crinitus* (Allred, 1958). Tooele Co.: *P. crinitus* (Keegan, 1953); *P. truei, Reithrodontomys megalotis* (Woodbury, 1956b). Washington Co.: *P. eremicus;* ? County: *P. truei* (Allred, 1958).

Other Utah records. Garfield Co.: *Microtus longicaudus.* San Juan Co.: *Corynorhinus rafinesquii.* Sanpete Co.: *P. crinitus.*

Seasonal occurrence. Fifty-two females of *E. debilis* were collected from March through August and in November. Greatest numbers were found in June and July. One female in July and one in November contained an egg and larva, respectively. Males and immature stages of this species likely are nest dwellers.

Comments. Mites of *E. debilis* are equally distributed throughout northern and southern Utah in both the Great and Upper Colorado River basins. They are known from 22 counties.

Eighty-five percent of its collections were from *Peromyscus* spp., and 53% from *P. maniculatus.* Its broad distribution over the state likely is related to the extensive distribution and variety of habitats of its preferred hosts.

In 12 of its 21 collections *E. debilis* was the only mite found on its host. In three collections it was associated with *Eubrachylaelaps circularis.*

KEY TO SPECIES OF FEMALE *Hypoaspis*

Anterolateral corners of sternal plate not extended, or when extended, with only narrow projections (Fig. 274) ..... *lubrica*

Anterolateral corners of sternal plate broadly extended (Fig. 277) ..... *gurabensis*

Hypoaspis lubrica Oudemans and Voigts, 1904

Figs. 57, 166, 274, 317, 591

Hypoaspis murinis Strandtmann and Menzies, of authors.

Utah records. Duchesne Co.: *Citellus lateralis, Peromyscus maniculatus.* Juab Co.: *P. maniculatus.* San Juan Co.: *Citellus spilosoma.* Summit Co.: *P. maniculatus.* Utah Co.: *P. maniculatus, Rattus norvegicus, Thomomys bottae.*

Seasonal occurrence. Twelve females were taken during February, May, June, August and November.

Comments. There is considerable variation in the Utah series, suggesting at least three different forms. These likely represent only variants of one species (Strandtmann, personal correspondence).

Hypoaspis gurabensis (Fox), 1946

Figs. 58, 161, 277, 313, 424

Distribution. ? locality: *Rattus norvegicus, Rattus rattus* (Thurman, Mulrennan and Branch, 1949). OKLAHOMA: *Sigmodon hispidus* (Ellis, 1960). UTAH: Daggett Co.: *Peromyscus maniculatus;* Kane Co.: *P. maniculatus* (Allred, 1957d). Tooele Co.: *P. maniculatus* (Woodbury, 1956b).

Other Utah records. Utah Co.: *Thomomys talpoides.*

Seasonal occurrence. Six females were taken in May, June and November.

Comments. Woodbury (1956b) reported *Hypoaspis* sp. from *Onychomys leucogaster* in Tooele Co., and Elzinga (1960) reported *Hypoaspis* sp. from Utah Co., host not designated. It is not known whether these belong to *H. gurabensis* or *H. lubrica.*

KEY TO SPECIES OF FEMALE *Haemolaelaps*

1. Genitoventral plate broadly expanded, almost touching anal plate (Fig. 318) ..... *casalis*, page 40

   Genitoventral plate normally expanded, distance between it and anal plate at least as great as length of anus (Fig. 323) 2

2. Anal plate about as broad as long, somewhat triangular in shape (Fig. 167) ..... *glasgowi*, page 40

   Anal plate longer than broad, pear-shaped (Fig. 162) ..... *geomys*, page 41

Haemolaelaps casalis
(Berlese), 1887
Figs. 65, 103, 168, 278, 318, 333, 592

Haemolaelaps megaventralis of authors (Strandtmann and Wharton, 1958).

Distribution. ARKANSAS, COLORADO, FLORIDA, GEORGIA, MONTANA, OHIO, PENNSYLVANIA, SOUTH CAROLINA, VIRGINIA: Variety of birds and rodents (Strandtmann and Wharton, 1958). NEVADA: *Neotoma lepida* (Allred and Goates, 1964b). OREGON: *Microtus montanus, N. lepida, Onychomys leucogaster* (Hansen, 1964). TEXAS: *Rattus norvegicus* (Eads, Menzies and Miles, 1952). UTAH: Daggett Co.: *Peromyscus maniculatus;* Emery Co.: *P. maniculatus;* Grand Co.: *P. maniculatus* (Allred, 1958). Juab Co.: *N. lepida* (Howell, Allred and Beck, 1957). Piute Co.: *Peromyscus truei;* San Juan Co.: *P. maniculatus* (Allred, 1958). Tooele Co.: *N. lepida* (Allred and Roscoe, 1957); *P. maniculatus* (Woodbury, 1956b). Uintah Co.: *P. maniculatus;* Utah Co.: *P. maniculatus, P. truei* (Allred, 1958).

Other Utah records. Beaver Co.: *Thomomys bottae.* Carbon Co.: *P. maniculatus, Spermophilus lateralis.* Emery Co.: *Peromyscus crinitus.* Kane Co.: *N. lepida, P. maniculatus.* San Juan Co.: *Peromyscus boylii, T. bottae.* Tooele Co.: *T. bottae.* Utah Co.: *Mus musculus, Rattus norvegicus, T. bottae, Thomomys talpoides.* Washington Co.: *Dipodomys merriami, N. lepida.*

Seasonal occurrence. Totals of 54 females and four deutonymphs were collected from April through December except in August. Females were taken in each of the months, and nymphs only in May. Each of two females in May and three in October contained a larva, and one female in October contained an egg.

Comments. Mites of this species are distributed over the state in both the Great and Upper Colorado River basins in 13 counties.

This species was taken from a variety of rodents, but was associated commonly with white-footed mice and gophers. *Peromyscus boylii* and *Thomomys umbrinus* (= *bottae*).

In nine of 22 collections *H. casalis* was the only mite on its host. It was associated with *Haemolaelaps glasgowi* in only four collections.

Haemolaelaps glasgowi
(Ewing), 1925
Figs. 66, 75, 98, 104, 167, 173, 280, 323, 344, 350, 371, 434, 593

Furman (1966) indicated synonymy of *Haemolaelaps fahrenholzi* Berlese, 1911 and *H. glasgowi.* However, for the purposes of this paper we prefer to retain the use of *H. glasgowi.*

Distribution. A variety of hosts from many states (Strandtmann, 1949; Pratt and Good, 1954; Strandtmann and Wharton, 1958). ALABAMA: Variety of rodents (Hays and Guyton, 1958). NEBRASKA: *Blarina brevicauda, Citellus tridecemlincatus, Pedomys orchrogaster, Peromyscus leucopus, Peromyscus maniculatus* (Rapp, 1962). NEVADA: *Dipodomys merriami, Dipodomys microps, Onychomys torridus, Perognathus* spp., *P. maniculatus, Peromyscus truei, Thomomys umbrinus* (Allred, 1962, 1963; Goates, 1963; Allred and Goates, 1964a). OKLAHOMA: *Perognathus hispidus, Pitymys* sp., *Sigmodon* sp. (Ellis, 1960). OREGON: Variety of rodents (Hansen, 1964). TEXAS: Variety of rodents (Eads, Menzies and Miles, 1952). UTAH: All counties except Juab and Millard: *P. maniculatus;* Duchesne Co.: *P. truei* (Allred, 1958). Juab Co.: *Neotoma lepida* (Howell, Allred and Beck, 1957). Salt Lake Co.: *Peromyscus boylii* (Allred, 1958). Summit Co.: *Marmota flaviventris* (Allred, 1961). Tooele Co.: *Citellus leucurus, D. microps, Dipodomys ordii, Eutamias minimus, N. lepida* (Ho, 1962); *Onychomys leucogaster* (Keegan, 1953); *Perognathus parvus* (Ho, 1962); *Peromyscus crinitus, P. maniculatus, Reithrodontomys megalotis* (Keegan, 1953); *N. lepida, P. parvus, P. truei* (Woodbury, 1956b). Utah Co.: *Citellus leucurus* (Elzinga, 1960); *D. microps, D. ordii* (Ho, 1962); *Rattus norvegicus* (Myklebust, 1951); *P. boylii* (Allred, 1958); *P. maniculatus* (Ho, 1962); *P. truei* (Allred, 1958); *R. megalotis* (Elzinga and Rees, 1964); *Vulpes macrotis* (Ho, 1962). Washington Co.: *P. crinitus, Peromyscus eremicus* (Allred, 1958). ? locality: *Citellus armatus, Citellus lateralis, Citellus variegatus* (Jenkins, 1965).

Other Utah records. Beaver Co.: *C. lateralis, C. leucurus, D. ordii.* Box Elder Co.: *D. ordii, E. minimus, Lepus californicus, Microtus longicaudus, P. parvus, O. leucogaster.* Cache Co.: *C. armatus, Microtus* sp. Carbon Co.: *C. armatus, C. lateralis, E. minimus, Eutamias quadrivittatus, M. longicaudus, P. parvus, Zapus princeps.* Daggett Co.: *C. lateralis, Citellus richardsoni, D. ordii, Microtus* sp. Duchesne Co.: *C. lateralis, C. leucurus, C. tridecemlineatus, Cynomys leucurus, D. ordii, E. minimus, M. flaviventris, P. parvus, Ochotona princeps.* Emery Co.: *C. variegatus, P. crinitus, P. truei.* Garfield Co.: *M. longicaudus, Perognathus formosus, P. parvus.* Grand Co.: *Citellus leucurus, C. variegatus, Geomys leucurus, D. ordii, Perognathus* sp., *O. leucogaster, Thomomys bottae.* Iron Co.: *Citellus townsendii, D. ordii, P. eremicus.* Juab Co.: *C. variegatus, D. microps, D. ordii, P. parvus, P. maniculatus, R. megalotis, Sylvilagus auduboni, T. bottae.* Kane Co.: *C. lateralis, C. variegatus, D. ordii, N. lepida, P. formosus, Perognathus longimembris, P. parvus, O. leucogaster, P. truei.* Piute Co.: *C. variegatus, N. lepida.* Rich Co.: *Microtus* sp., Salt Lake Co.: *C. armatus, Microtus montanus.* San Juan Co.: *Citellus leucurus, D. ordii, E. minimus, M. longicaudus, Perognathus* sp., *O. leucogaster, P. boylii, P. truei.* Sanpete Co.: *C. armatus, C. lateralis, C. variegatus.* Sevier Co.: *D. ordii, Microtus* sp., *P. parvus.* Summit Co.: *C. armatus, C. lateralis.* Uintah Co.: *Citellus leucurus, Cynomys* sp., *C. tridecemlincatus, D. ordii,* Utah Co.: *C. armatus, C. lateralis, C. variegatus, M. longicaudus, M. montanus, Microtus pennsylvanicus, Mus musculus, Neotoma cinerea, P. parvus, Tamiasciurus hudsonicus, Thomomys talpoides.* Wasatch Co.: *C. armatus, C. lateralis.* Washington Co.: *C. leucurus, C. variegatus, D. merriami, D. microps, L. californicus, N. lepida, P. formosus, O. torridus, Thomomys* sp. Wayne Co.: *C. variegatus,* "chipmunk." *N. lepida, Perognathus* sp., *P. truei.*

Seasonal occurrence. Totals of 106 males, 1987 females, 39 protonymphs and 146 deutonymphs were taken. Mites were collected every

month of the year, although greatest numbers were taken in June. Females were taken each month, mainly in June; males from March through December, mostly in June and December; protonymphs from February through August and in November, mostly in February and June; and deutonymphs from February through August and in November and December, mainly in April, June and July. Each of 235 females contained an egg, and 91 contained a larva. Gravid females with eggs were taken from March through December, whereas those with larvae were taken from November through August except January. Gravid mites were taken mostly from March through July.

Comments. Mites of *H. glasgowi* are widely distributed over the state and are known from every county except Davis, Millard and Weber.

This species was taken from a variety of rodents, although it was found most commonly on squirrels (*Citellus* spp.), kangaroo rats (*Dipodomys* spp.), white-footed mice (*Peromyscus* spp.) and voles (*Microtus* spp.). The highest parasite indices occurred on *O. torridus*, *M. pennsylvanicus*, *R. norvegicus*, *C. variegatus* and *Cynomys leucurus*, with ratings of 36, 28, 21, 13 and 11, respectively. Other hosts had mite indices of nine or less.

In 202 of 428 collections, *H. glasgowi* was the only mite on its host.

Haemolaelaps geomys
Strandtmann, 1949
Figs. 162, 285, 316

Distribution. CALIFORNIA, FLORIDA, ILLINOIS, OREGON, TEXAS: *Cratogeomys* sp., *Geomys* sp., *Neotoma* sp., *Peromyscus* sp., *Thomomys sp.*; GEORGIA: *Geomys* sp. (Strandtmann, 1949). NEBRASKA: *Geomys bursarius* (Rapp, 1962). UTAH: Tooele Co.: *Onychomys leucogaster* (Woodbury, 1956b).

Other Utah records. None.

Comments. We doubt the validity of the Utah record above. The record likely was of *Haemolaelaps glasgowi* or *H. casalis*.

Listrophoridae Canestrini, 1892

Mites of this family are found clinging to the hair of small mammals. Occasionally they attack the skin and cause a type of mange. They are worldwide in distribution.

KEY TO GENERA OF LISTROPHORIDAE

Legs III and IV modified as clasping organs (Fig. 597) ..... *Myocoptes*

Legs III and IV not as above, similar to legs I and II (Fig. 599) ..... *Listrophorus*

Myocoptes sp.
Fig. 597

Distribution. COLORADO: *Geomys bursarius* (Miller and Ward, 1960). MARYLAND: *Microtus pennsylvanicus, Mus musculus, Peromyscus leucopus* (Drummond, 1957). UTAH: Utah Co.: *Peromyscus maniculatus, Reithrodontomys megalotis* (Elzinga and Rees, 1964).

Other Utah records. None.

Comments. Only superficial examination of the host and debris likely accounts for the few Utah records of these very small mites.

Listrophorus sp.
Fig. 599

Distribution. DELAWARE: *Microtus pennsylvanicus, Peromyscus leucopus* (Florschutz and Darsie, 1960). MARYLAND: *Blarina brevicauda, M. pennsylvanicus, P. leucopus, Pitymys pinetorum* (Drummond, 1957). NEVADA: *Dipodomys merriami, Dipodomys microps* (Goates, 1963). UTAH: Garfield Co.: *Peromyscus maniculatus;* Salt Lake Co.: *P. maniculatus* (Allred, 1957d). Tooele Co.: *Dipodomys ordii, Perognathus longimembris* (Woodbury, 1956b). Utah Co.: *P. longimembris, P. maniculatus* (Elzinga, 1960). TEXAS: *Liomys* sp., *Sylvilagus floridanus* (Randolph and Eads, 1946; Eads, Trevino, and Campos, 1965).

Other Utah records. Tooele Co.: *Perognathus formosus.*

Seasonal occurrence: A single mite was taken in March.

Comments. Elzinga (1960) listed *L. dipodomius* from Utah County, but did not designate a host, although he indicated *Listrophorus* sp. from two hosts (see Distribution above).

It is likely that this species is more common in Utah than suspected. The few specimens represented may be due to superficial collecting techniques. Eads, Trevino, and Campos (1965) reported that in Texas half of the mice (*Liomys* sp.) examined were infested, one so heavily that there were several mites on most hairs on its back. Jameson (1950) indicated that *Listrophorus* sp. was the most numerous ectoparasite on shrews, as abundant as 500 per animal.

MYOBIIDAE Megnin, 1877

Myobiids are worldwide in distribution, found clinging to the hairs of small mammals. Their association with hair follicles may result in local dermatitis and secondary infection. Although usually not considered parasitic, Wharton and his associates demonstrated that myobiids do suck body fluids (Strandtmann, personal correspondence).

KEY TO GENERA OF MYOBIIDAE

Tarsus II with single claw ..... *Myobia*
Tarsus II with paired claws ..... *Radfordia*

Myobia sp.

Distribution. UTAH: Tooele Co.: *Neotoma lepida* (Allred and Roscoe, 1957).

Other Utah records. None.

Comments. It is unusual that more specimens of fur mites are not represented in Utah collections. Collection techniques may be at fault.

KEY TO SPECIES OF FEMALE *Radfordia*

1. Dorsolateral seta I hooked near tip (Fig. 595) ..... *bachai*
   Dorsolateral seta I not hooked 2
2. Submedian seta I as long as submedian III (Fig. 10) ..... *lemnina*
   Submedian seta I about one-half as long as submedian III (Fig. 9) ..... *subuliger*

Radfordia bachai Howell and Elzinga, 1962

Figs. 99, 595

Distribution. UTAH: Tooele Co., Utah Co.: *Dipodomys ordii* (Howell and Elzinga, 1962).

Other Utah records. None.

Radfordia lemnina (Koch), 1841

Figs. 10, 596

Distribution. MARYLAND: *Microtus pennsylvanicus, Pitymys pinetorum* (Drummond, 1957). UTAH: Garfield Co.: *Peromyscus maniculatus* (Allred, 1957d).

Other Utah records. None.

Radfordia subuliger Ewing, 1938

Fig. 9

Distribution. MARYLAND: *Peromyscus leucopus* (Drummond, 1957). UTAH: Tooele Co.: *Peromyscus maniculatus* (Woodbury, 1956b). Utah Co.: *P. maniculatus* (Allred, 1957d); *Reithrodontomys megalotis* (Elzinga and Rees, 1964).

Other Utah records. None.

TROMBICULIDAE Ewing, 1944

Mites of this family in the larval stage are important parasites of vertebrates the world over. They are commonly found attached to the integument of mammals where they appear as a single engorged mite or as small red, yellow, orange, or white patches in the ears, around the vibrissae, genitalia, thighs and axillary regions.

KEY TO GENERA OF LARVAL TROMBICULIDAE

1. Leg I with seven segments; coxa I with one seta 2
   Leg I with six segments; coxa I with two setae 3

2. Two anteromedian scutal setae (Fig. 435) ..... *Bernia*
   One or no anteromedian scutal seta (Figs. 381, 437) 6

3. Scutum with anteromedian projection (Fig. 373) 4
   Scutum without anteromedian projection (Fig. 379) 5

4. Cheliceral blade with dorsal and/or ventral row of teeth (Fig. 4); spiracles and tracheae present ..... *Odontacarus*, page 44
   Cheliceral blade without dorsal or ventral teeth; spiracles and tracheae absent ..... *Leeuwenhoekia*, page 45

5. Cheliceral blade with distinct row of teeth (Fig. 4); spiracles and tracheae present ..... *Whartonia*, page 45
   Cheliceral blade with tricuspid cap (Fig. 6); spiracles and tracheae absent ..... *Chatia*, page 45

6. Anteromedian scutal seta present (Fig. 381) 7
   Anteromedian scutal seta absent (Fig. 437) ..... *Gahrliepia*, page 46

7. Sensilla flagelliform (Fig. 381) ..... *Trombicula*, page 46
   Sensilla expanded (Fig. 409) 8

8. Legs II and III with six segments ..... *Cheladonta*, page 50
   Legs II and III with seven segments ..... *Euschoengastia*, page 51

Bernia, new genus

Eyes present. Chelicera has tricuspid cap. Palpal claw trifurcate. Each tarsus has two claws and a claw-like empodium. Coxa III has three setae. Scutum has three pairs of setae similar in form: anteromedians, anterolaterals, and posterolaterals; anteromedians surrounded by distinct suture isolating the pair from rest of scutum; no anterior median projection; sensilla flagelliform, situated near posterior margin of scutum.

Genotype: *Bernia marita*, new species.

This distinctive genus is named in honor of the senior author's wife, Berna.

The paired, anterior median scutal setae relate this genus to the subfamily Apoloniinae which includes the genera *Womersia*, *Apolonia* and *Sauracarella*. However, some members of the subfamily Trombiculinae show considerable variation, especially in the AM setae. Members of the Apoloniinae are known principally from the southern hemisphere from reptiles and birds, and the only known North American representative is a species from a pelican in Texas. On the basis of its only known host, it seems reasonable to tentatively place *Bernia* with the Trombiculinae.

We realize the inadvisability of designating a new genus and species on the basis of only one specimen, but we feel that it is distinctive enough to warrant separation from other known genera and species.

Bernia marita, new species
Fig. 435

Type data. Larval holotype, University of Utah Institute of Environmental Biological Research specimen no. 1365:OOX. Taken from a female *Perognathus longimembris*, specimen no. ER2865, five miles N of Wig Mountain, Tooele

Co., Utah, in sand dunes associated with grasses, 24 June 1953, by Dale Parker and John Smith. In the acarology collection of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah. The trivial name *marita* is Latin for "wife," referring to the source of the generic name.

Larva

Body. Almost round; small, width 204; length (including capitulum) 228; one pair eyes, ocular plate lacking.

Gnathosoma. Cheliceral blade slightly curved, with prominent tricuspid cap; basal segment of chelicera longer than wide. Punctae absent. Palpal setae: femoral seta heavily branched; genual seta branched; ventral tibial seta branched on left side, forked on right side; lateral and dorsal tibial setae nude. Tarsus has tarsala, two nude and three or four branched setae; palpotibial claw trifurcate. Galeal seta with four or five branches.

Scutum. Roughly trapezoidal, three times as wide as long. Anterior margin concave, posterior margin convex, lateral margins slightly convex with posterior lateral corners somewhat pointed. Scutum impunctate. Sensillary bases situated on posterior edge of scutum, posterior to level of PL's; separated little wider than distance from SB to PL. Sensilla with 10 to 14 branches on distal half, proximal half with short barbs. Scutal setae plumose; AM posterior to AL; AM equals AL but shorter than PL; AM surrounded by prominent ridge. Prominent ridge along posterior border posterior to and ending lateral to SB.

Legs. Coxae punctate. Setae on legs as follows: I—coxa: 1 branched; trochanter: 1 branched; basifemur: 1 branched; telofemur: 5 branched; genu: 2 genualae, 1 microgenuala, 4 branched; tibia: 2 tibialae, 1 microtibiala, 8 branched; tarsus: tarsala, microtarsala, subterminala, parasubterminala, pretarsala, empodium, and about 14 branched. II—coxa: 1 branched; trochanter: 1 branched; basifemur: 2 branched; telofemur: 4 branched; genu: 1 genuala, 4 branched; tibia: 2 tibialae, 8 branched; tarsus: tarsala, microtarsala, pretarsala, empodium, and about 14 branched. III—coxa: right side 4 branched, left side 3 branched; trochanter: 1 branched; basifemur: 2 branched; telofemur: 3 branched; genu: 1 genuala, 3 branched; tibia: 1 tibiala, 6 branched; tarsus: 1 mastitarsala, empodium, and about 11 branched.

Body Setae. Single humeral seta on each shoulder; about 26 dorsal setae, the first post humeral row with 8 setae; two pairs sternal setae; about 10 ventral setae posterior to sternals.

KEY TO SPECIES OF LARVAL *Odontacarus*

1. Sensilla nude (Fig. 378) 2
   Sensilla branched (Fig. 376) ..... *linsdalei*
2. Two genulae I (Fig. 2) ..... *hirsutus*, page 45
   One genuala I ..... *micheneri*

Odontacarus linsdalei
(Brennan and Jones), 1954
Fig. 376

Distribution. CALIFORNIA: *Citellus beecheyi, Dipodomys agilis, Perognathus californicus* (Brennan and Jones, 1954; Loomis and Bunnell, 1962). NEVADA: *Dipodomys merriami, Dipodomys microps, Neotoma lepida, Onychomys torridus, Perognathus formosus, Perognathus longimembris, Perognathus parvus, Peromyscus maniculatus* (Allred, 1962, 1963; Goates, 1963; Allred and Goates, 1964a, 1964b). UTAH: Beaver Co.: *D. microps* (Brennan and Beck, 1955); *Dipodomys ordii, P. parvus* (Brennan and Jones, 1954). Juab Co.: *P. formosus* (Brennan and Beck, 1955); *P. parvus* (Brennan and Jones, 1954). Tooele Co.: *D. ordii* (Woodbury, 1956b); *P. parvus* (Brennan and Jones, 1954); *P. maniculatus* (Woodbury, 1956b). Utah Co.: *P. parvus* (Brennan and Jones, 1954). Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. Utah Co.: *D. ordii.*

Seasonal occurrence. Fourteen mites were taken in April, July, August, September and December.

Comments. In three of the seven collections, *O. linsdalei* was the only mite on its host.

Odontacarus micheneri
Greenberg, 1952
Fig. 375

Distribution. COLORADO: *Neotoma cinerea* (Greenberg, 1952). NEVADA: Lizards (Allred and

Beck, 1962). UTAH: Box Elder Co.: *Neotoma lepida, Sylvilagus* sp.; Garfield Co.: *N. lepida, Perognathus parvus;* Grand Co.: *N. lepida;* Piute Co.: *N. lepida;* Tooele Co.: *N. lepida, N. cinerea;* Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. Kane Co.: *N. lepida.* Washington Co.: *Onychomys torridus.*

Seasonal occurrence. Fifty-four mites were taken, mostly in June, but also in July and August.

Comments. Mites of *O. micheneri* were more common in the southern part of Utah, and are known from seven counties.

This species apparently has a preference for wood rats (*Neotoma* spp.).

In ten of 13 collections, *O. micheneri* was the only mite on its host.

Odontacarus hirsutus (Ewing), 1931

Fig. 378

Distribution. CALIFORNIA: *Aplodontia rufa, Citellus beecheyi, Citellus lateralis, Dipodomys venustus, Eutamias* sp., *Microtus californicus, Neotoma fuscipes, Perognathus californicus, Sylvilagus* sp., *Thomomys bottae* (Brennan and Jones, 1954; Gould, 1956; Jameson and Brennan, 1957). NEVADA: *Bassariscus astutus* (Allred and Goates, 1964a). UTAH: Grand Co.: *Neotoma* sp. (Brennan and Beck, 1955). Tooele Co.: ? host (Woodbury, 1956b).

Other Utah records. Grand Co.: *Neotoma lepida.* Kane Co.: *N. lepida.* Tooele Co.: *Neotoma cinerea.* Utah Co.: *Mus musculus, N. cinerea.*

Seasonal occurrence. Forty-eight mites were taken in February, May and July.

Comments. In the six collections, *O. hirsutus* was found alone twice, and with *Chatia ochotona* once.

The variations of the palpal claw, galeal and laterotibial setae in this species indicates a close relationship with *Odontacarus chiapanensis.*

Leeuwenhoekia americana (Ewing), 1942

Fig. 373

Distribution. ALABAMA: Cotton mouse; CALIFORNIA: *Citellus beecheyi, Microtus californicus, Peromyscus maniculatus, Sorex pacificus, Sorex trowbridgii, Sorex vagrans, Thomomys bottae* (Brennan and Jones, 1954; Gould, 1956). COLORADO: *Neotoma cinerea, Neotoma mexicana;* KANSAS: *P. maniculatus, Reithrodontomys megalotis* (Loomis, 1956). NEVADA: *Neotoma lepida* (Allred and Goates, 1964b). OREGON: Western mole (Gould, 1956). UTAH: Utah Co.: *P. maniculatus* (Ash, 1963).

Other Utah records. None.

Whartonia perplexa (Brennan), 1947

Fig. 379

Distribution. ARIZONA: Bats (Bradshaw and Ross, 1961). CALIFORNIA: *Antrozous pacificus, Pipistrellus hesperus* (Gould, 1956). MONTANA: *Eptesicus fuscus* (Brennan, 1947). NEVADA: *Antrozous pallidus* (Allred and Goates, 1964a). UTAH: Salt Lake Co.: *A. pallidus;* San Juan Co.: *Myotis californicus* (Brennan and Beck, 1955).

Other Utah records. Millard Co.: Bat.

Seasonal occurrence. The 30 mites were taken in August.

KEY TO SPECIES OF LARVAL *Chatia*

Genuala III and empodium present (Fig. 2) ..... *ochotona*

Genuala III and empodium absent ..... *setosa*

Chatia setosa Brennan, 1946

Fig. 384

Distribution. CALIFORNIA: *Eutamias townsendii, Peromyscus maniculatus* (Gould, 1956). IDAHO: *Citellus lateralis, P. maniculatus* (Brennan, 1946b). MONTANA: *C. lateralis, Neotoma cinerea, Ochotona princeps, P. maniculatus, Tamiasciurus hudsonicus* (Brennan, 1946b). UTAH: Cache Co.: *P. maniculatus* (Brennan and Beck, 1955). Utah Co.: *P. maniculatus* (Ash, 1963). WASHINGTON: ? host (Brennan and Beck, 1955).

Other Utah records. Utah Co.: *O. princeps.*

Seasonal occurrence. Nine chiggers were taken in June and August.

Comments. Chiggers of *C. setosa* were taken most commonly from deer mice (*Peromyscus maniculatus*) from two counties in Utah.

This mite was associated with other chiggers in two collections, and was found alone twice.

Chatia ochotona (Radford), 1942

Fig. 382

Shunsennia ochotona (Radford) of authors (Traub and Nadchatram, 1966).

Distribution. CALIFORNIA: *Clethrionomys californicus, Microtus longicaudus, Ochotona schisticeps, Peromyscus boylii, Peromyscus maniculatus, Sorex trow-*

bridgii (Gould, 1956; Jameson and Brennan, 1957). IDAHO: ? host (Brennan and Beck, 1955). MONTANA: *Ochotona* sp. (Gould, 1956). NEVADA: ? host (Brennan and Beck, 1955). UTAH: Cache Co.: *P. maniculatus* (Brennan and Beck, 1955). Millard Co.: *P. maniculatus* (Allred, 1957d). Tooele Co.: *Neotoma cinerea* (Brennan and Beck, 1955). Utah Co.: *P. maniculatus* (Ash, 1963).

Other Utah records. None.

Seasonal occurrence. A total of 39 mites was taken from May through August, and in January and November.

Comments. In seven of 18 collections, *C. ochotona* was the only mite on its host. It was associated with chiggers of other species in six collections.

Gahrliepia americana Ewing, 1942
Fig. 437

Walchia americana of authors (Brennan and Jones, 1959).

Distribution. CALIFORNIA: "Gray squirrel"; FLORIDA: "Cotton mouse" (Gould, 1956). IOWA: *Peromyscus leucopus;* KANSAS: *Neotoma micropus, P. leucopus, Sciurus carolinensis, Sciurus niger, Sylvilagus floridanus* (Loomis, 1956). MARYLAND: *P. leucopus* (Drummond, 1957). NEBRASKA: *S. carolinensis, S. niger;* OKLAHOMA: *Neotoma floridana, P. leucopus* (Loomis, 1956). UTAH: Garfield Co.: *Eutamias umbrinus;* WISCONSIN: ? host (Brennan and Beck, 1955).

Other Utah records. None.

KEY TO SPECIES OF LARVAL *Trombicula*

1. Sensilla nude (Fig. 385) ..... *californica*, page 47
   Sensilla branched (Fig. 387) 2
2. Palpal claw trifurcate (Fig. 6) 3
   Palpal claw bifurcate; accessory prong inner and ventral ..... *belkini*, page 47
3. One pair of humeral setae (Fig. 2) 4
   Two pairs of humeral setae ..... *hoplae*, page 48
4. Palpal femoral, genual, laterotibial, and ventrotibial setae nude; galeal setae branched; two genuala I 5
   Without this combination of characters 7
5. Palpal dorsotibial setae branched (Fig. 6) ..... *myotis*, page 48
   Palpal dorsotibial setae nude 6
6. Spur on tarsus I longer than on tarsus II; palpal genual, laterotibial, and ventrotibial setae occasionally forked ..... *potosina*, page 48
   Spur on tarsus I equal to one on tarsus II ..... *panamensis*, page 48
7. Mastitibiala III present (Fig. 2) 8
   Mastitibiala III absent 11
8. Two mastitarsalae III; mastifemorala present (Fig. 2) 9
   Three mastitarsalae III; mastifemorala III absent ..... *subsignata*, page 48
9. Galeal seta nude (Fig. 6) ..... *harperi*, page 49
   Galeal seta branched 10
10. Palpal femoral and genual setae branched (Fig. 6) ..... *jewetti*, page 49
    Palpal femoral and genual setae nude ..... *harperi*, page 49

11. Scutum pentagonal with acute posterior angle (Fig. 398); sensillae branched or barbed the entire length (Fig. 398); coxa III with two or more setae; with three genualae I 12

Without this combination of characters 13

12. Coxa III with two setae ..... *sargenti*, page 49

Coxa III with five setae ..... *esoensis*, page 49

13. Mastitarsala III present (Fig. 2) 15

Mastitarsala III absent 14

14. Sensillae heavily branched and rebranched (Fig. 393) ..... *univari*, page 49

Sensillae simply branched (Fig. 403) ..... *kardosi*, page 49

15. Two mastitarsalae III (Fig. 2) 18

One mastitarsala III 16

16. Coxa III with one seta (Fig. 5); palpal dorsotibial seta branched (Fig. 6) ..... *bakeri*, page 49

Coxa III with three or four setae; palpal dorsotibial seta nude 17

17. Dorsal formula begins 2-8-8; cheliceral bases punctate ..... *arenicola*, page 50

Dorsal formula begins 2-6-6; cheliceral bases impunctate ..... *montanensis*, page 50

18. Palpal dorsotibial and laterotibial setae nude; about 100 dorsal setae; no distinct humerals ..... *doremi*, page 50

Palpal dorsotibial and laterotibial setae branched; about 28 dorsal setae, one pair distinct humerals ..... *allredi*, page 50

A number of workers have proposed that none of the Utah species of chiggers belong to the genus *Trombicula, sensu stricto,* as currently defined. However, for the purposes of our study we have retained in *Trombicula, sensu lato,* those species which belong to the subfamily Trombiculinae and possess a flagelliform sensilla.

Trombicula californica Ewing, 1942

Fig. 385

Distribution. CALIFORNIA: Variety of rodents (Brennan and Wharton, 1950; Brennan and Jones, 1954; Gould, 1956; Jameson and Brennan, 1957). IDAHO: *Citellus lateralis;* MONTANA: *Sylvilagus nuttallii, Tamiasciurus hudsonicus* (Brennan and Wharton, 1950). UTAH: Cache Co.: *Peromyscus maniculatus;* Rich Co.: *Clethrionomys gapperi, Microtus longicaudus* (Brennan and Beck, 1955). Salt Lake Co.: *P. maniculatus* (Allred, 1957d). Sanpete Co.: *Citellus armatus* (Brennan and Beck, 1955).

Other Utah records. Utah Co.: *C. armatus, Zapus princeps.*

Seasonal occurrence. Ninety-four mites were taken in June and August.

Comments. Mites of this species were found only in five counties in northwestern Utah in the Great Basin.

In three of its six collections, *T. californica* was the only mite on its host. In one collection it was associated with a chigger of another species.

Trombicula belkini Gould, 1950

Fig. 381

Distribution. ARIZONA: ? host; CALIFORNIA: *Citellus beecheyi, Marmota flaviventris, Mus musculus, Perognathus californicus, Peromyscus truei,* reptiles (Gould, 1950, 1956; Brennan and Jones, 1954). NEVADA: *Neotoma lepida, Perognathus longimembris,* reptiles (Allred and Beck, 1962, 1964; Allred, 1963;

Allred and Goates, 1964b). UTAH: Duchesne Co.: *Citellus leucurus;* Emery Co.: *Crotaphytus collaris;* Garfield Co.: *C. collaris;* Grand Co.: *Cnemidorphorus tigris, C. collaris;* Juab Co.: *Gambelia wislizenii, P. truei* (Brennan and Beck, 1955); *Pituophis catenifer* (Gould, 1956); *Uta stansburiana;* Millard Co.: *Sceloporus graciosus;* Sevier Co.: *Citellus lateralis;* Utah Co.: S. *graciosus* (Brennan and Beck, 1955).

Other Utah records. Duchesne Co.: *Dipodomys ordii.* Rich Co.: *Clethrionomys gapperi.*

Seasonal occurrence. Seven mites were taken in June, July and August.

Comments. Mites of this species commonly are found on lizards. They occasionally infest rodents, but in such cases their population index is usually low. This species is known from nine counties.

In its five collections, *T. belkini* was the only mite on its host.

Trombicula hoplai Loomis, 1954

Fig. 388

Distribution. CALIFORNIA: *Perognathus californicus, Peromyscus californicus, Peromyscus maniculatus* (Brennan and Jones, 1954; Loomis, 1956). COLORADO: *Neotoma lepida, Neotoma mexicana,* (Loomis, 1954; Finley, 1958). KANSAS: *Antrozous bunkeri, Cynomys ludovicianus, Neotoma micropus, Peromyscus leucopus, Sylvilagus floridanus;* NEW MEXICO: *Neotoma mexicana, Perognathus flavus;* TEXAS: *Citellus tridecemlineatus* (Loomis, 1954, 1956). UTAH: Juab Co.: *Peromyscus truei;* San Juan Co.: *Perognathus apache* (Brennan and Beck, 1955). Tooele Co.: *P. truci* (Woodbury, 1956b). Utah Co.: ? host (Elzinga, 1960), *N. lepida* (Ho, 1962).

Other Utah records. Kane Co.: *Perognathus parvus.* San Juan Co.: *P. truei.* Uintah Co.: *Citellus leucurus.*

Seasonal occurrence. The 14 mites were taken in June, August and September.

Trombicula myotis Ewing, 1929

Fig. 387

Distribution. ARIZONA: Bats (Bradshaw and Ross, 1961). ARKANSAS: *Sylvilagus floridanus* (Loomis, 1956). CALIFORNIA: ? host (Brennan and Beck, 1955). IOWA: *Microtus pinetorum, Peromyscus leucopus;* KANSAS: *Elaphe obsoleta, Neotoma micropus;* MAINE: *Myotis lucifugus;* MISSOURI: *Eptesicus fuscus;* MONTANA: *E. fuscus;* NEBRASKA: *P. leucopus, Sciurus niger* (Loomis, 1956). NEW MEXICO: *Sigmodon* sp.; NEW YORK: ? host (Brennan and Beck, 1955). OKLAHOMA: *Neotoma floridana;* PENNSYLVANIA: *E. fuscus* (Loomis, 1956). UTAH: Daggett Co.: *Peromyscus maniculatus* (Allred, 1957d). Tooele Co.: Bat (Woodbury, 1956b). Utah Co.: *Myotis californicus* (Brennan and Beck, 1955). VIRGINIA: *E. fuscus;* WEST VIRGINIA: *E. fuscus, M. lucifugus* (Yunker, 1958).

Other Utah records. Beaver Co.: *Myotis* sp. Box Elder Co.: *Myotis* sp. Rich Co.: *P. maniculatus.* Tooele Co.: *Myotis* sp.

Seasonal occurrence. The 83 mites were taken in June and July, mostly in June.

Comments. Mites of this species were taken commonly in the northern part of the state in the Great Basin. They are known from six counties.

This species occurs frequently on bats, but also attaches regularly to rodents.

In six of its seven collections, *T. myotis* was the only mite on its host.

Trombicula potosina Hoffman, 1950

Fig. 391

Distribution. COLORADO: *Neotoma albigula, Neotoma cinerea, Neotoma lepida, Neotoma mexicana* (Finley, 1958). UTAH: Beaver Co.: *Perognathus parvus;* Iron Co.: *Neotoma lepida;* Juab Co.: *N. lepida;* Millard Co.: *N. lepida;* San Juan Co.: *Neotoma* sp.; Sanpete Co.: *Microtus longicaudus;* Tooele Co.: *N. lepida;* Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. None.

Trombicula panamensis Ewing, 1925

Fig. 390

Distribution. NEVADA: *Neotoma lepida* (Allred and Goates, 1964b).

Utah records. Beaver Co.: *Peromyscus maniculatus.* Kane Co.: *N. lepida, P. maniculatus.*

Seasonal occurrence. The 22 mites were taken in June, August and September.

Comments. In two of five collections, *T. panamensis* was the only mite on its host. In one collection it was associated with *Odontacarus micheneri.*

Trombicula subsignata Brennan and Wharton, 1950

Fig. 392

Distribution. CALIFORNIA: *Citellus beldingi, Marmota flaviventris* (Gould, 1956). COLORADO: *Citellus lateralis* (Brennan and Wharton, 1950). MISSOURI: *Capella gallinago* (Kardos, 1954). MONTANA: *C. lateralis, M. flaviventer;* NEW YORK: *Microtus pennsylvanicus, Zapus hudsonicus;* NORTH DAKOTA: *Sylvilagus floridanus;* PENNSYLVANIA: *M. pennsylvanicus, Sciurus motacilla* (Brennan and Wharton, 1950). WYOMING: *Zapus princeps* (Kardos, 1954).

Utah records. Juab Co.: *Reithrodontomys megalotis.*

Seasonal occurrence. A single chigger was taken in June.

Trombicula harperi Ewing, 1928
Fig. 394

Gould (1956) indicated that the variations in *Trombicula harperi* and *Trombicula microti* are great. He discussed them as representatives of a single polymorphic species, *T. harperi* having priority. Our collections agree with Gould's descriptions, especially in the variability of the galeal and humeral setae. Consequently, records of *T. microti* are included here.

Distribution. ARIZONA, CALIFORNIA, COLORADO, IDAHO, MAINE, MICHIGAN, MONTANA, NEW MEXICO, NEW YORK, OREGON, PENNSYLVANIA, VERMONT, WASHINGTON, WYOMING: Variety of rodents (Brennan and Wharton, 1950; Kardos, 1954; Brennan and Beck, 1955; Gould, 1956; Jameson and Brennan, 1957; Finley, 1958). UTAH: Beaver Co.: *Ochotona princeps;* Duchesne Co.: *O. princeps;* Iron Co.: *O. princeps* (Brennan and Beck, 1955); *Peromyscus maniculatus* (Allred, 1957d). Juab Co.: *Gambelia* sp., *Neotoma lepida;* Sanpete Co.: *Citellus armatus, Clethrionomys gapperi, Marmota flaviventer, Microtus longicaudus* (Brennan and Beck, 1955); *P. maniculatus* (Allred, 1957d); *Zapus princeps;* Sevier Co.: *Microtus* sp. (Brennan and Beck, 1955). Summit Co.: *O. princeps* (Kardos, 1954). Tooele Co.: *Melospiza lincolni* (Brennan and Beck, 1955). Utah Co.: *Marmota flaviventris* (Allred, 1961); *O. princeps;* Wasatch Co.: *O. princeps, Z. princeps;* Wayne Co.: *O. princeps* (Brennan and Beck, 1955).

Other Utah records. Beaver Co.:*Microtus longicaudus.* Carbon Co.: *Citellus lateralis.* Daggett Co.: *P. maniculatus.* Iron Co.: *C. lateralis.* Salt Lake Co.: *C. gapperi.* San Juan Co.: *Onychomys leucogaster.* Summit Co.: *Eutamias minimus.* Uintah Co.: *Homo sapiens, M. longicaudus.* Utah Co.: *Microtus montanus, O. princeps, Perognathus parvus, Z. princeps.* Washington Co.: *Microtus montanus.*

Seasonal occurrence. A total of 2,242 chiggers was taken. Mites were most abundant in August, although small numbers were found in March, May, June, July, September and November.

Comments. Mites of *T. harperi* occur generally over the state. They are known from 17 counties.

This species apparently prefers the pika, *Ochotona princeps,* as its host, although it has been commonly found on jumping mice and voles. Its population index was 107 on pikas, 6 on jumping mice, 11 to 126 on voles, and from 1 to 59 on other rodents.

In 44 of 68 collections, *T. harperi* was the only mite on its host. In 13 collections it was associated with chiggers of other species.

Trombicula jewetti Brennan and Wharton, 1950
Fig. 395

Distribution. CALIFORNIA: Variety of rodents (Brennan and Wharton, 1950; Brennan and Jones, 1954; Jameson and Brennan, 1957). OREGON: *Microtus townsendii* (Brennan and Wharton, 1950). UTAH: Duchesne Co.: *Peromyscus maniculatus* (Allred, 1957d).

Other Utah records. None.

Trombicula sargenti Brennan, 1952
Fig. 398

Distribution. UTAH: Juab Co.: *Neotoma lepida* (Brennan, 1952; Brennan and Beck, 1955). Utah Co.: *N. lepida* (Allred and Beck, 1953a).

Other Utah records. None.

Trombicula esoensis Sasa and Ogata, 1953
Fig. 397

The Utah record below was described as a new species, *T. reesi,* by Allred (1957d). Brennan and Jones (1959) placed this into synonymy with *T. esoensis.*

Distribution. MICHIGAN, MONTANA: ? host (Brennan and Jones, 1959). UTAH: Salt Lake Co.: *Peromyscus maniculatus* (Allred, 1957d).

Other Utah records. None.

Trombicula univari Brennan, 1965
Fig. 393

Distribution. ARIZONA: *Antrozous pallidus, Pipistrellus hesperus, Plecotus townsendii* (Brennan, 1965).

Utah records. San Juan Co.: *P. hesperus.*

Seasonal occurrence. Two mites were taken in September.

Trombicula kardosi Loomis, 1954
Fig. 403

Distribution. KANSAS: *Elaphe obsoleta, Sciurus niger;* UTAH: Garfield Co.: *Eutamias umbrinus* (Loomis, 1954).

Other Utah records. None.

Trombicula bakeri Ewing, 1946
Fig. 399

Distribution. Apparently not known heretofore from the United States.

Utah records. Kane Co.: *Peromyscus maniculatus.* Utah Co.: *Citellus armatus, Dipodomys ordii.*

Seasonal occurrence. Only three mites were taken—one each in June, July and August.

Trombicula arenicola Loomis, 1954

Fig. 406

Distribution. COLORADO: *Dipodomys ordii, Neotoma albigula;* KANSAS: *D. ordii, Muscivora forficata, Perognathus hispidus* (Loomis, 1954). NEVADA: *Dipodomys merriami, Dipodomys microps, Onychomys torridus, Perognathus formosus, Perognathus longimembris,* reptiles, *Sorex tenellus, Spermophilus tereticaudus* (Allred, 1962, 1963; Goates, 1963; Allred and Beck, 1964; Allred and Goates, 1964a). NEW MEXICO: *D. ordii, Perognathus flavus* (Loomis, 1954). UTAH: Box Elder Co.: *Dipodomys* sp., *Neotoma lepida, Perognathus* sp.; Daggett Co.: *Perognathus parvus;* Garfield Co.: *Cynomys parvidens;* Grand Co.: *Perognathus* sp.; Juab Co.: *D. microps, P. formosus;* Millard Co.: *D. microps;* Sanpete Co.: *Peromyscus maniculatus;* Sevier Co.: *D. ordii* (Brennan and Beck, 1955). Tooele Co.: *D. microps, D. ordii* (Loomis, 1954); *P. formosus* (Brennan and Beck, 1955); *P. longimembris* (Woodbury, 1956b); *P. parvus* (Loomis, 1954); *P. maniculatus* (Woodbury, 1956b); snakes; Uintah Co.: *D. ordii* (Brennan and Beck, 1955). Utah Co.: *Citellus leucurus* (Ho, 1962); *D. ordii, P. parvus* (Brennan and Beck, 1955); *P. maniculatus, Reithrodontomys megalotis* (Elzinga and Rees, 1964). Washington Co.: *P. formosus, P. longimembris;* Wayne Co.: *D. ordii* (Brennan and Beck, 1955.

Other Utah records. Beaver Co.: *Perognathus* sp. Box Elder Co.: *Perognathus* sp. Grand Co.: *Perognathus* sp. Juab Co.: *P. parvus.* Kane Co.: *Peromyscus truei.* San Juan Co.: *Citellus spilosoma, D. ordii.* Washington Co.: *Dipodomys merriami.*

Seasonal occurrence. The 653 mites were taken from February through October, except in March. Most were found in August, with about half as many taken in July and October. Few were taken during the other months.

Comments. Mites of *T. arenicola* are common in the southern part of Utah, and about equally distributed in the Great and Upper Colorado River basins. They are known from 16 counties.

This species apparently prefers pocket mice of the genus *Perognathus* as its hosts, although mites were taken frequently on kangaroo rats, particularly *D. microps.* The population index was 11 to 14 on kangaroo rats, 5 to 21 on pocket mice, and 1 to 4 on other animals.

In 53 of 68 collections, *T. arenicola* was the only mite on its host. It was associated with chiggers of other species in seven collections.

Trombicula montanensis Brennan, 1946

Fig. 402

Distribution. CALIFORNIA: *Citellus beldingi, Citellus lateralis, Dipodomys heermani* (Gould, 1956). COLORADO: ? host (Brennan and Beck, 1955; Loomis, 1956). KANSAS: Variety of rodents, birds, and reptiles (Loomis, 1956). MONTANA: *Cynomys ludovicianus, Sylvilagus nuttallii* (Brennan, 1946a). NEBRASKA: ? host (Brennan and Beck, 1955; Loomis, 1956). OKLAHOMA: *Heterodon platyrhinos, Tadarida mexicana* (Loomis, 1956). TEXAS: *C. ludovicianus* (Eads, Menzies, and Miles, 1952). UTAH: Duchesne Co.: *Cynomys leucurus* (Brennan and Beck, 1955). Kane Co.: *Peromyscus truei;* Rich Co.: *Peromyscus maniculatus;* Sanpete Co.: *P. maniculatus* (Allred, 1957d). Tooele Co.: *Peromyscus crinitus* (Woodbury, 1956b).

Other Utah records. Box Elder Co.: *C. lateralis.*

Seasonal occurrence. The single mite was taken in June.

Trombicula doremi Brennan and Beck, 1955

Fig. 404

Distribution. UTAH: Kane Co.: *Perognathus longimembris* (Brennan and Beck, 1955). Utah Co.: ? host (Elzinga, 1960), *Dipodomys ordii* (Ho, 1962). Washington Co.: *Dipodomys merriami* (Brennan and Beck, 1955).

Other Utah records. Beaver Co.: *Perognathus* sp.

Seasonal occurrence. The single mite was taken in August.

Comments. According to Loomis (personal correspondence) this specimen is aberrant, having duplicated PL setae on both sides. It agrees generally with the type description and compares favorably with a paratype.

Trombicula allredi Brennan and Beck, 1955

Fig. 405

Distribution. CALIFORNIA: *Neotoma* sp., *Sigmodon hispidus* (Gould, 1956). NEVADA: *Dipodomys merriami, Dipodomys microps, Neotoma lepida* (Goates, 1963; Allred and Goates, 1964b). TEXAS: *Liomys* sp. (Eads, Trevino, and Campos, 1965). UTAH: Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. None.

Cheladonta crossi Lipovsky, Crossley and Loomis, 1955

Distribution. UTAH: Cache Co.: *Peromyscus maniculatus* (Lipovsky, Crossley and Loomis, 1955).

Other Utah records. None.

KEY TO SPECIES OF LARVAL *Euschoengastia*

1. Tibiala III present (Fig. 2) 2
   Tibiala III absent 9

2. Subterminala and parasubterminala present (Fig. 2) 5
   Subterminala and parasubterminala absent 3

3. Genualae II and III absent ..... *lacerta*, page 52
   Genualae II and III present 4

4. One pair of humeral setae (Fig. 2) ..... *hoffmanmae*, page 52
   Two pairs of humeral setae ..... *furmani*, page 52

5. Genualae II and III present 6
   Genualae II and III absent ..... *utahensis*, page 52

6. Sternal setae 2:2 (Fig. 5); palpal claw five-pronged 7
   Sternal setae 2:4 or 2:6; palpal claw trifurcate (Fig. 6) 8

7. Palpal laterotibial seta nude (Fig. 6) ..... *soricinus*, page 52
   Palpal laterotibial seta branched ..... *oregonensis*, page 53

8. Sternal setae 2:4 ..... *cordiremus*, page 53
   Sternal setae 2:6 ..... *cynomyicola*, page 53

9. Two genualae I (Fig. 2) 11
   One genuala I 10

10. Palpal claw trifurcate (Fig. 6); laterotibial seta nude or with 1 or 2 branches (Fig. 6) ..... *lanei*, page 53
    Palpal claw five-pronged; laterotibial seta branched ..... *deeipiens*, page 53

11. Genuala III present 13
    Genuala III absent 12

12. Palpal claw trifurcate (Fig. 6); galeal seta nude or forked (Fig. 6) ..... *luteodema*, page 54
    Palpal claw five-pronged; galeal seta branched (Fig. 4) ..... *pomerantzi*, page 54

13. Subterminala and parasubterminala present (Fig. 2) 14
    Subterminala and parasubterminala absent ..... *fassola*, page 54

14. One pair of humeral setae (Fig. 2) 15
    Two pairs of humeral setae ..... *rotunda*, page 54

15. Palpal claw trifurcate (Fig. 6) 16
    Palpal claw with four to seven prongs 19

16. Scutum and cheliceral bases punctate (Fig. 408) 17
Scutum and cheliceral bases impunctate (Fig. 417) 18

17. Sensilla capitate; AL equal to PL (Fig. 408) ..... *radfordi*, page 54
Sensilla pyriform; AL shorter than PL (Fig. 413) ..... *obesa*, page 55

18. Dorsal setae of two forms—majority narrow lanceolate, rest of usual form ..... *lanceolata*, page 55
Dorsal setae of usual form ..... *criceticola*, page 55

19. Sensilla capitate; AL equal to or greater than PL (Fig. 408) ..... *radfordi*, page 54
Sensilla cordate; AL shorter than PL; scutum and cheliceral bases impunctate (Fig. 422) ..... *sciuricola*, page 55

Euschoengastia lacerta
Brennan, 1948
Fig. 430

Distribution. CALIFORNIA: *Citellus beecheyi, Neotoma fuscipes, Perognathus californicus, Peromyscus boylii, Peromyscus maniculatus, Reithrodontomys* sp., *Sceloporus occidentalis, Sylvilagus audubonii* (Brennan, 1948; Brennan and Jones, 1954; Gould, 1956; Jameson and Brennan, 1957). COLORADO: *Neotoma albigula, Neotoma cinerea, Neotoma mexicana;* KANSAS: *Cynomys ludovicianus, Neotoma micropus, Sylvilagus floridanus* (Loomis, 1956). NEVADA: *Dipodomys microps* (Goates, 1963). TEXAS: *Liomys* sp. (Eads, Trevino and Campos, 1965). UTAH: Garfield Co.: *Neotoma lepida;* Tooele Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. Duchesne Co.: *Citellus lateralis.*

Seasonal occurrence. Five larvae were collected in July and August.

Comments. Chiggers of *E. lacerta* are known from both the Great and Upper Colorado River basins. They have been found in only three counties.

This species has been taken from a variety of hosts, but more commonly from *Neotoma* spp. than from others.

Euschoengastia hoffmannae
Gould, 1956
Fig. 433

Distribution. CALIFORNIA: *Citellus lateralis* (Gould, 1956). COLORADO: *Neotoma mexicana* (Finley, 1958). UTAH: Sevier Co.: *C. lateralis* (Brennan and Beck, 1955).

Other Utah records. Beaver Co.: *C. lateralis.* Sanpete Co.: *C. lateralis.* Summit Co.: *Ochotona princeps.*

Seasonal occurrence. A total of 105 larval *E. hoffmannae* was collected in June and August. Greatest numbers were found in June.

Comments. Specimens were found most commonly in southwestern Utah in the Great Basin. This species is known from only four counties.

Most collections and greatest numbers of *E. hoffmanae* were taken from the squirrel, *C. lateralis.*

In three of its five collections, *E. hoffmannae* was associated with chiggers of other species. In one collection it was the only mite on its host.

Euschoengastia furmani Gould, 1956
Fig. 432

Distribution. CALIFORNIA: *Citellus leucurus, Neotoma lepida, Perognathus californicus, Reithrodontomys megalotis* (Gould, 1956). UTAH: Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. None.

Euschoengastia utahensis
Brennan and Beck, 1955
Fig. 426

Distribution. NEVADA: *Neotoma lepida* (Allred and Goates, 1964b). UTAH: Juab Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. Washington Co.: *Perognathus formosus.*

Seasonal occurrence. A single chigger was collected in April.

Euschoengastia soricinus
Gould, 1956
Fig. 425

Distribution. CALIFORNIA: *Sorex palustris, Sorex trowbridgii* (Gould, 1956).

Utah records. One chigger was taken from *Ochotona princeps* in Utah County in August.

Comments. Loomis (personal correspondence) indicated that the Utah specimen is similar to *soricinus* from California, but the sensilla is a different shape. This may represent an undescribed species, but is here tentatively relegated to *E. soricinus*.

Euschoengastia oregonensis
(Ewing), 1929
Fig. 428

Distribution. CALIFORNIA: *Citellus beldingi, Citellus lateralis, Eutamias townsendii, Microtus californicus* (Gould, 1956); *Neurotrichus* sp. (Jameson and Brennan, 1957); *Sorex pacificus, Sorex palustris, Sorex towbridgii, Tamiasciurus douglasii;* MONTANA: Pika; OREGON: Mole (Gould, 1956). UTAH: Cache Co.: *Peromyscus maniculatus;* Iron Co.: *Ochotona princeps, Sorex obscurus;* Sevier Co.: *Microtus* sp.; Utah Co.: *O. princeps;* Wayne Co.: *O. princips;* WASHINGTON: ? host (Brennan and Beck, 1955).

Other Utah records. Beaver Co.: *Microtus longicaudus. O. princeps.* Box Elder Co.: *M. longicaudus, Perognathus parvus.* Duchesne Co.: *P. maniculatus.* Sevier Co.: *Eutamias quadrivittatus.*

Seasonal occurrence. A total of 226 larval *E. oregonensis* was collected in June, July, August and November. Greatest numbers were taken in July.

Comments. Chiggers of this species are common in the Great Basin. They are known from eight counties.

This species is most closely associated with the pika, *O. princeps,* and other hosts such as shrews and voles living in a similar habitat.

In seven of 14 collections *E. oregonensis* was the only mite on its host. In five collections it was associated with chiggers of other species.

Euschoengastia cordiremus
Brennan, 1948
Fig. 429

Distribution. CALIFORNIA: *Citellus beldingi, Marmota* sp. (Gould, 1956). MONTANA: *Citellus lateralis, Peromyscus maniculatus* (Brennan, 1948) NEVADA: ? host, *P. maniculatus* (Brennan and Beck, 1955; Allred and Goates, 1964a). UTAH: Cache Co.: *P. maniculatus* (Brennan and Beck, 1955). Utah Co.: *P. maniculatus* (Ash, 1963).

Other Utah records. Box Elder Co.: *C. lateralis, Perognathus parvus.*

Seasonal occurrence. Sixteen larval *E. cordiremus* were taken in June, July and October.

Comments. Mites of this species are known only from three counties in northwestern Utah in the Great Basin.

In its three collections, *E. cordiremus* was associated each time with mites of a different species of *Euschoengastia* and with other mesostigmatids.

Euschoengastia cynomyicola
Crossley and Lipovsky, 1954
Fig. 423

Distribution. NEBRASKA: *Cynomys ludovicianus;* KANSAS: *Citellus tridecemlineatus. C. ludovicianus, Perognathus hispidus* (Crossley and Lipovsky, 1954).

Utah records. San Juan Co.: *Citellus spilosoma.*

Seasonal occurrence. Nine mites were collected in May.

Euschoengastia lanei Brennan
and Beck, 1955
Fig. 419

Distribution. NEVADA: *Peromyscus maniculatus* (Allred and Goates, 1964a). UTAH: Box Elder Co.: *P. maniculatus, Reithrodontomys megalotis;* Uintah Co.: *P. maniculatus* (Brennan and Beck, 1955).

Other Utah records. Utah Co.: *Ochotona princeps.*

Seasonal occurrence. Two specimens were taken in July.

Comments. This species has been taken from both the Great and Upper Colorado River basins.

Euschoengastia decipiens
Gould, 1956
Fig. 431

This species is very similar to *Euschoengastia radfordi* and may prove to be synonymous with it. The two are differentiated by the presence of two genualae I on *radfordi* and one genuala I on *decipiens.* In a series of chiggers taken from *Lepus californicus* in southern Utah, four mites possess two genualae I and two have one genuala I.

Distribution. CALIFORNIA: *Perognathus parvus* (Gould, 1956). NEVADA: ? host, *Dipodomys merriami, Dipodomys microps, Perognathus formosus, Perognathus longimembris, P. parvus* (Brennan and Beck, 1955; Allred, 1963; Goates, 1963; Allred and Goates, 1964a). OREGON: ? host (Brennan and Beck, 1955). UTAH: Box Elder Co.: *Lepus californicus;* Cache Co.: *Peromyscus maniculatus;* Duchesne Co.: *Citellus lateralis;* Garfield Co.: *C. lateralis;* Tooele Co.: *Neotoma lepida;* Utah Co.: *Dipodomys ordii, P. parvus;* Washington Co.: *D. merriami, P. formosus, P. longimembris* (Brennan and Beck, 1955).

Other Utah records. Box Elder Co.: *P. maniculatus, Sylvilagus idahoensis.* Daggett Co.: *Peromyscus truei.* Juab Co.: *L. californicus, Sylvilagus audubonii.* Kane Co.: *D. ordii, N. lepida, P. parvus.* San Juan Co.: *P. maniculatus.* Sanpete Co.: *C. lateralis, Erethizon dorsatum.* Utah Co.: *D. microps, P. maniculatus, Sylviligus nuttallii.* Washington Co.: *L. californicus, Peromyscus crinitus, Peromyscus eremicus, S. audubonii.*

Seasonal occurrence. A total of 1,129 larval *E. decipiens* was collected. Mites were found during February through June, and in August and November. Greatest numbers were taken in February, March and April.

Comments. Mites of *E. decipiens* are known from the Great and Upper Colorado River Basins in 12 counties in Utah.

This species has been taken from a variety of rodents, but the majority of the collections were as follows: 28% from *Dipodomys* spp., 25% from rabbits, 24% from *Perognathus* spp., and 11% from *Peromyscus* spp. Twenty percent of the collections were from *D. ordii,* and 15% from *L. californicus.*

In 32 of 55 collections, *E. decipiens* was the only mite on its host. In only seven collections was it associated with other species of chigger mites.

Euschoengastia luteodema
Brennan, 1948

Fig. 420

Distribution. CALIFORNIA: *Marmota flaviventris* (Gould, 1956). IDAHO: *M. flaviventer* (Brennan, 1948). MONTANA: *Citellus columbianus, M. flaviventer, Tamiasciurus hudsonicus* (Brennan, 1948). UTAH: Beaver Co.: *M. flaviventris* (Allred, 1961). Cache Co.: *Peromyscus maniculatus* (Brennan and Beck, 1955). Utah Co.: *P. maniculatus* (Ash, 1963).

Other Utah records. Duchesne Co.: *Citellus lateralis.*

Seasonal occurrence. A total of 114 larval *E. luteodema* was collected during January, June, and from September through November. Greatest numbers were found in June.

Comments. Mites of this species have been found in both the Great and Upper Colorado River basins, but are more common at the northerly latitudes. They are known from only four counties.

In seven of its ten collections, *E. luteodema* was associated with chiggers of other species. In two instances it was apparently the only mite on its host.

Euschoengastia pomerantzi
Brennan and Jones, 1954

Fig. 416

Distribution. CALIFORNIA: *Citellus beecheyi, Citellus lateralis, Microtus californicus, Mus musculus, Neotoma fuscipes, Perognathus californicus, Peromyscus boylii, Peromyscus californicus, Peromyscus maniculatus, Peromyscus truei, Tamiasciurus douglasii* (Brennan and Jones, 1954; Gould, 1956). NEVADA: ? host; UTAH: Garfield Co.: *Eutamias umbrinus* (Brennan and Beck, 1955).

Other Utah records. Garfield Co.: *P. maniculatus, P. truci.*

Seasonal occurrence. The 49 mites were taken in June.

Comments. This species is known in Utah from only one county.

Euschoengastia fasolla
Brennan and Beck, 1955

Fig. 414

Distribution. NEVADA: *Eutamias dorsalis, Neotoma lepida, Perognathus parvus* (Allred, 1963; Allred and Goates, 1964a, 1964b). UTAH: Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. None.

Euschoengastia rotunda
Brennan and Beck, 1955

Fig. 411

Distribution. UTAH: San Juan Co.: *Ochotona princeps* (Brennan and Beck, 1955). Utah Co.: *Peromyscus maniculatus* (Ash, 1963).

Other Utah records. None.

Euschoengastia radfordi
Brennan and Jones, 1954

Fig. 408

Euschoengastia decipiens (Gould, 1956) may be synonymous with this species. Refer to comments under *E. decipiens.*

Distribution. CALIFORNIA: Variety of rodents and birds (Brennan and Jones, 1954); Jameson and Brennan, 1957). IDAHO: ? host; MONTANA: ? host (Brennan and Beck, 1955). NEVADA: *Dipodomys merriami, Dipodomys microps, Neotoma lepida* (Goates, 1963; Allred and Goates, 1964b). OREGON: ? host; UTAH: Garfield Co.: *Erethizon dorsatum;* Tooele Co.: *Junco canicceps* (Brennan and Beck, 1955); *Peromyscus crinitus* (Woodbury 1956b). Utah Co.: *D. microps* (Ho, 1962); *Peromyscus maniculatus, Reithrodontomys megalotis* (Elzinga and Rees, 1964). Washington Co.: *N. lepida* (Brennan and Beck, 1955).

Other Utah records. Box Elder Co.: *Lepus californicus, Sylvilagus idahoensis.* Juab Co.: *D. microps.*

Tooele Co.: *N. lepida*. Utah Co.: *Dama hemionus, Dipodomys ordii*. Washington Co.: *Perognathus formosus, Peromyscus eremicus*.

Seasonal occurrence. A total of 97 larval mites was collected in February, March, April, May, June and December; they were most abundant in March.

Comments. Mites of this species are more common in the northern part of Utah, but were taken about equally from the Great and Upper Colorado River basins. They are known from six counties.

In four of its 12 collections, *E. radfordi* was the only mite on its host. In seven collections it was associated with chiggers of other species.

Euschoengastia obesa Brennan and Beck, 1955

Fig. 413

Distribution. NEVADA: *Neotoma lepida* (Allred and Goates, 1964b). UTAH: Duchesne Co.: *Cynomys leucurus;* Tooele Co.: *Perognathus formosus;* Utah Co.: *Peromyscus maniculatus;* Wayne Co.: *P. maniculatus* (Brennan and Beck, 1955).

Other Utah records. San Juan Co.: *P. maniculatus*. Tooele Co.: *P. maniculatus*.

Seasonal occurrence. The two collections in September and October totaled 66 mites.

Comments. Mites were taken from both the Great and Upper Colorado River basins. Mites of this species are known from five counties.

In both collections, *E. obesa* was the only mite found on its host.

Euschoengastia lanceolata Brennan and Beck, 1955

Fig. 417

Distribution. UTAH: Washington Co.: *Neotoma lepida, Peromyscus eremicus* (Brennan and Beck, 1955).

Other Utah records. None.

Euschoengastia criceticola Brennan, 1948

Fig. 409

In the specimens from Utah there is considerable variation in the shape of the scutum. This is true for mites taken from the same host.

Distribution. CALIFORNIA: Variety of rodents (Brennan and Jones, 1954; Gould, 1956; Jameson and Brennan, 1957; Loomis and Bunnell, 1962). COLORADO: Variety of rodents (Loomis, 1956; Finley, 1958). IDAHO: *Citellus lateralis* (Brennan, 1948). KANSAS: Variety of rodents (Loomis, 1956). MONTANA: *Peromyscus maniculatus* (Brennan 1948). NEVADA: *Neotoma lepida, Onychomys torridus, Perognathus formosus, Perognathus parvus, P. maniculatus, Sorex tenellus* (Allred, 1962, 1963; Allred and Goates, 1964a, 1964b). UTAH: Box Elder Co.: *P. maniculatus;* Carbon Co.: *P. maniculatus;* Daggett Co.: *P. maniculatus;* Duchesne Co.: *P. maniculatus;* Emery Co.: *P. maniculatus;* Garfield Co.: *P. maniculatus* (Allred, 1954a). Juab Co.: *N. lepida* (Brennan and Beck, 1955). Kane Co.: *P. maniculatus;* Sevier Co.: *P. maniculatus* (Allred, 1954a). Tooele Co.: *Dipodomys microps* (Ho, 1962); *N. lepida, P. formosus* (Woodbury, 1956b), *P. maniculatus* (Brennan and Beck, 1955). *P. truei* (Woodbury 1956b). *Reithrodontomys megalotis* (Ho. 1962). Utah Co.: *D. microps* (Ho, 1962); *Dipodomys ordii* (Brennan and Beck, 1955); *Peromyscus boylii, P. maniculatus* (Allred, 1954a); *R. megalotis* (Elzinga and Rees, 1964). Washington Co.: *N. lepida* (Brennan and Beck, 1955); *Peromyscus eremicus;* Wayne Co.: *P. maniculatus* (Allred, 1954a). WYOMING: Variety of rodents (Loomis, 1956).

Other Utah records. Beaver Co.: *Citellus lateralis*. Duchesne Co.: *C. lateralis*. Grand Co.: *P. maniculatus*. Kane Co.: *N. lepida*. Salt Lake Co.: *Citellus armatus*. San Juan Co.: *P. maniculatus*. Summit Co.: *Ochotona princeps*. Tooele Co.: *Citellus townsendii*. Utah Co.: *O. princeps*. Wasatch Co.: *P. maniculatus*.

Seasonal occurrence. A total of 263 larval *E. criceticola* was collected. Mites were found every month of the year, but were more frequently taken in May, June, August and December.

Comments. Chiggers of *E. criceticola* are distributed over the northern and southern parts of Utah and in the Great and Upper Colorado River basins. They are known from 19 counties of the state.

Peromyscus spp. were the hosts for this chigger in 66% of the samples, and 60% of these were from *P. maniculatus*.

In 24 of its 41 collections, *E. criceticola* was the only mite on its host. In 13 collections it was associated with chigger mites of other species.

Euschoengastia sciuricola (Ewing), 1925

Fig. 422

Distribution. CALIFORNIA: *Citellus beecheyi, Citellus lateralis, Eutamias townsendii, Lepus californicus, Marmota flaviventris,* "mouse," *Peromyscus maniculatus* (Gould 1956; Jameson and Brennan, 1957). IDAHO: ? host, "chipmunk" (Brennan and Beck, 1955; Farrell, 1956). MONTANA: ? host, *Sciurus hudsonicus* (Brennan and Beck, 1955. Gould, 1956). NEW MEXICO: ? host (Brennan and Beck, 1955). UTAH: Cache Co.: *Eutamias umbrinus;* Duchesne Co.: *Tamiasciurus hudsonicus* (Brennan and Beck, 1955). Garfield Co.: *P. maniculatus* (Allred, 1957d). Sanpete Co.: *Citellus*

armatus, C. lateralis; Sevier Co.: *C. lateralis* (Brennan and Beck, 1955). Tooele Co.: *P. maniculatus* (Allred, 1957d); *Reithrodontomys megalotis* (Woodbury, 1956b). Utah Co.: *Citellus variegatus* (Brennan and Beck, 1955).

Other Utah records. Beaver Co.: *C. lateralis, M. flaviventris.* Box Elder Co.: *C. lateralis.* Carbon Co.: *C. lateralis, M. flaviventris.* Duchesne Co.: *Ochotona princeps.* Summit Co.: *Eutamias minimus.* Utah Co.: *C. armatus, E. minimus, O. princeps, P. maniculatus.*

Seasonal occurrence. A total of 209 larval *E. sciuricola* was collected from May through September. Greatest numbers were found in June and July.

Comments. Chiggers of this species are common in northern Utah and in the Great Basin. They are known from 11 counties.

This species is most frequently associated with squirrels of the genus *Spermophilus* (= *Citellus*). Also they are found frequently on other rodents, such as chipmunks, pikas and marmots, which live at high elevations in mountainous areas.

In 11 of 22 collections, *E. sciuricola* was the only mite on its host. In all other collections except one it was associated with chiggers of other species.

TETRANYCHIDAE Donnadieu, 1875

Fig. 598

Mites of this family are important parasites and pests of plants. Their accidental occurrence on mammals in our studies likely resulted from the mammal's close association with plants.

CHEYLETIDAE Leach, 1814

Fig. 598

Mites of this family are predaceous, and likely are associated with the fauna in the nests of small mammals. They were found occasionally in our studies, but unlikely as parasites of the mammals.

TABLE 2. MITE-HOST RELATIONSHIPS IN UTAH.

Hosts indicated with an asterisk are those on which the mite was found most frequently. Where applicable, the percentage of animals infested is designated. Species not marked with an asterisk or percentage seldom were infested, represent previous records from Utah for which the infestation rate is not known, or were taken in insufficient numbers to warrant designation. Names of hosts are as indicated in collection records or literature references. For a revised listing of these, see Table 3.

Androlaelaps leviculus	
Citellus armatus	
Citellus lateralis	
Dipodomys ordii	
°*Onychomys leucogaster*	3%
°*Perognathus apache*	8%
°*Perognathus formosus*	3%
Perognathus parvus	
Peromyscus crinitus	
Peromyscus maniculatus	
Bernia marita	
Perognathus longimembris	
Brevisterna montanus	
Eutamias quadrivittatus	3%
Brevisterna utahensis	
Citellus variegatus	
Dipodomys merriami	
Lepus californicus	
°*Mus musculus*	5%
°*Neotoma cinerea*	12%
°*Neotoma lepida*	11%
Onychomys leucogaster	
Perognathus formosus	
°*Peromyscus boylii*	7%
Peromyscus crinitus	
Peromyscus eremicus	
Peromyscus maniculatus	
Peromyscus truei	
Chatia ochotona	
Neotoma cinerea	
Peromyscus maniculatus	
Chatia setosa	
Ochotona princeps	
Peromyscus maniculatus	
Dermanyssus becki	
Eutamias quadrivittatus	
Lepus californicus	
Marmota flaviventris	
Neotoma albigula	
°*Neotoma lepida*	8%
Peromyscus boylii	
°*Peromyscus crinitus*	5%
Peromyscus eremicus	
Peromyscus maniculatus	
Peromyscus truei	
Dermanyssus gallinae	
Neotoma lepida	
Onychomys leucogaster	

Peromyscus crinitus
Dermanyssus sanguineus
Peromyscus eremicus
Rattus norvegicus
Eubrachylaelaps circularis
Lepus californicus
Neotoma lepida
Perognathus longimembris
Perognathus parvus
°*Peromyscus boylii* 14%
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
°*Peromyscus truei* 23%
Sylvilagus audubonii
Eubrachylaelaps crowei
°*Onychomys leucogaster* 9%
Perognathus sp.
Eubrachylaelaps debilis
°*Corynorhinus rafinesque* 6%
Microtus longicaudus
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
Peromyscus truei
Reithrodontomys megalotis
Eubrachylaelaps hollisteri
Neotoma lepida
Perognathus parvus
°*Peromyscus crinitus* 6%
Peromyscus eremicus
Peromyscus maniculatus
Peromyscus truei
Eulaelaps stabularis
Citellus armatus
Microtus sp.
Peromyscus maniculatus
Rattus norvegicus
Euschoengastia cordiremus
Citellus lateralis
Perognathus parvus
Peromyscus maniculatus
Euschoengastia criceticola
Citellus armatus
Citellus lateralis
Citellus townsendii
Dipodomys microps
Dipodomys ordii
Neotoma lepida
Ochotona princeps
Perognathus formosus
°*Peromyscus boylii* 7%
Peromyscus eremicus
Peromyscus maniculatus
Peromyscus truei
Reithrodontomys megalotis
Euschoengastia cynomyicola
Citellus spilosoma
Euschoengastia decipiens
Citellus lateralis
Dipodomys merriami
Dipodomys microps
Dipodomys ordii
Erethizon epixanthum
Lepus californicus
Neotoma lepida
Perognathus formosus
°*Perognathus longimembris* 5%
Perognathus parvus
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
Peromyscus truei
°*Sylvilagus audubonii* 7%
°*Sylvilagus idahoensis* 12%
°*Sylvilagus nuttallii* 5%
Euschoengastia fasolla
Neotoma lepida
Euschoengastia furmani
Neotoma lepida
Euschoengastia hoffmannae
Citellus lateralis
Ochotona princeps
Euschoengastia lacerta
Citellus lateralis
Neotoma lepida
Euschoengastia lanei
Ochotona princeps
Peromyscus maniculatus
Reithrodontomys megalotis
Euschoengastia lanceolata
Neotoma lepida
Peromyscus eremicus
Euschoengastia luteodema
Citellus lateralis
Marmota flaviventris
Peromyscus maniculatus
Euschoengastia obesa
Peromyscus maniculatus
Euschoengastia oregonensis
Eutamias quadrivittatus
Microtus longicaudus
°*Ochotona princeps* 5%
Perognathus parvus
Peromyscus maniculatus
Sorex obscurus
Euschoengastia pomerantzi
Eutamias umbrinus
Peromyscus maniculatus
Peromyscus truei
Euschoengastia radfordi
Dama hemionus
Dipodomys microps
Dipodomys ordii
Erethizon dorsatum
Lepus californicus
Neotoma lepida
Perognathus formosus
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
Reithrodontomys megalotis
°*Sylvilagus idahoensis* 6%
Euschoengastia rotunda
Peromyscus maniculatus
Euschoengastia sciuricola
Citellus armatus
°*Citellus lateralis* 5%
Citellus variegatus
Eutamias minimus
Eutamias umbrinus
Marmota flaviventris
°*Ochotona princeps* 5%
Peromyscus maniculatus
Reithrodontomys megalotis
°*Tamiasciurus hudsonicus* 6%
Euschoengastia soricinus
Ochotona princeps

Euschoengastia utahensis
Neotoma lepida
Perognathus formosus
Galtriepia americana
Eutamias umbrinus
Haemogamasus alaskensis
Blarina brevicauda (probably *Sorex* sp.)
Microtus longicaudus
Ochotona princeps
Peromyscus maniculatus
Zapus princeps
Haemogamasus ambulans
Citellus armatus
Citellus lateralis
Clethrionomys gapperi
Dipodomys ordii
Eutamias umbrinus
Glaucomys sabrinus
Microtus longicaudus
Microtus montanus
Mus musculus
°*Neotoma cinerea* 12%
Neotoma lepida
Ochotona princeps
Onychomys leucogaster
Perognathus parvus
Peromyscus maniculatus
Peromyscus truei
Tamiasciurus hudsonicus
Thomomys bottae
°*Thomomys talpoides* 5%
°*Zapus princeps* 6%
Haemogamasus liponyssoides
Blarina brevicauda (probably *Sorex* sp.)
Microtus longicaudus
Haemogamasus longitarsus
Microtus longicaudus
Peromyscus maniculatus
Thomomys talpoides
Haemogamasus pontiger
Eutamias quadrivittatus
Neotoma lepida
°*Peromyscus boylii* 7%
Peromyscus eremicus
Peromyscus maniculatus
Haemolaelaps casalis
Citellus lateralis
Dipodomys merriami
°*Mus musculus* 5%
Neotoma lepida
°*Peromyscus boylii* 7%
Peromyscus crinitus
Peromyscus maniculatus
Peromyscus truei
Rattus norvegicus
°*Thomomys bottae* 10%
Thomomys talpoides
Haemolaelaps geomys
Onychomys leucogaster
Haemolaelaps glasgowi
°*Citellus armatus* 10%
°*Citellus lateralis* 15%
°*Citellus leucurus* 10%
Citellus richardsonii
Citellus townsendii
Citellus tridecemlineatus
°*Citellus variegatus* 24%
°*Cynomys leucurus* 35%
°*Dipodomys merriami* 10%
Dipodomys microps
Dipodomys ordii
Eutamias minimus
Eutamias quadrivittatus
Lepus californicus
Marmota flaviventris
°*Microtus longicaudus* 12%
Microtus mexicanus
°*Microtus montanus* 19%
Microtus pennsylvanicus
°*Mus musculus* 15%
Neotoma cinerea
°*Neotoma lepida* 10%
Ochotona princeps
°*Onychomys leucogaster* 33%
Onychomys torridus
Perognathus formosus
Perognathus longimembris
Perognathus parvus
Peromyscus boylii
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
°*Peromyscus truei* 10%
Rattus norvegicus
Reithrodontomys megalotis
Sylvilagus audubonii
Tamiasciurus hudsonicus
Thomomys bottae
Thomomys talpoides
Zapus princeps
Hirstionyssus affinis
Eutamias minimus
Perognathus formosus
Peromyscus truei
Hirstionyssus bisetosus
Neotoma lepida
Hirstionyssus femuralis
Citellus armatus
°*Mustela frenata* 10%
Neotoma lepida
Peromyscus eremicus
°*Thomomys bottae* 7%
Thomomys talpoides
Hirstionyssus geomydis
Neotoma lepida
Hirstionyssus hilli
Dipodomys ordii
Neotoma lepida
Onychomys leucogaster
Perognathus flavus
Perognathus longimembris
Perognathus parvus
Peromyscus eremicus
Peromyscus maniculatus
Hirstionyssus incomptus
Citellus variegatus
Citellus leucurus
Dipodomys merriami
°*Dipodomys microps* 6%
°*Dipodomys ordii* 9%
Microtus longicaudus
Neotoma lepida
Perognathus longimembris
Perognathus parvus
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
Rattus norvegicus

Reithrodontomys megalotis
Hirstionyssus isabellinus
Citellus armatus
Eutamias quadrivittatus
°*Microtus longicaudus* 4%
°*Microtus montanus* 6%
Microtus pennsylvanicus
Ochotona princeps
Onychomys torridus
Peromyscus maniculatus
Phenacomys intermedius
Reithrodontomys megalotis
Thomomys talpoides
Hirstionyssus neotomae
Dipodomys ordii
°*Neotoma cinerea* 6%
Neotoma lepida
Perognathus parvus
Peromyscus maniculatus
°*Peromyscus truei* 4%
Thomomys talpoides
*Hirstionyssus stafford*i:
Spilogale gracilis 10%
Hirstionyssus triacanthus
Citellus leucurus
Dipodomys merriami
°*Dipodomys microps* 10%
°*Dipodomys ordii* 6%
Lepus californicus
Neotoma lepida
Perognathus formosus
Perognathus longimembris
Peromyscus crinitus
Peromyscus eremicus
Peromyscus maniculatus
Rattus norvegicus
Reithrodontomys megalotis
Hirstionyssus thomomys
Thomomys talpoides 3%
Hirstionyssus longichelae
°*Thomomys talpoides* 3%
Ochotona princeps
Hirstionyssus punctatus
Eutamias minimus
Eutamias quadrivittatus
Glaucomys sabrinus
Peromyscus maniculatus
Hirstionyssus tarsalis
Peromyscus maniculatus
Hirstionyssus torus
Sciurus aberti
Hirstionyssus palustris
Sorex palustris
Hirstionyssus angustus
Citellus armatus
Hirstionyssus eutamiae
°*Eutamias quadrivittatus* 3%
Reithrodontomys megalotis
Hirstionyssus utahensis
Citellus armatus
Citellus lateralis
Citellus tridecemlineatus
Dipodomys ordii
°*Eutamias minimus* 5%
°*Eutamias quadrivittatus* 12%
Neotoma lepida
Perognathus longimembris
Peromyscus crinitus
Peromyscus maniculatus
Peromyscus truei
Reithrodontomys megalotis
Thomomys talpoides
Hirstionyssus invaginatus
°*Citellus armatus* 6%
°*Mus musculus* 5%
Thomomys talpoides
Hypoaspis gurabensis
Peromyscus maniculatus
Thomomys talpoides
Hypoaspis lubrica
Citellus lateralis
Citellus spilosoma
Peromyscus maniculatus
Rattus norvegicus
Thomomys bottae
Icharonyssus robustipes
Tadarida mexicana
Ischyropoda armatus
Citellus variegatus
Dipodomys merriami
°*Dipodomys microps* 7%
Dipodomys ordii
Erethizon epixanthum
Lepus californicus
Myotis californicus
°*Onychomys leucogaster* 27%
Onychomys torridus
Perognathus flavus
°*Perognathus formosus* 5%
Perognathus longimembris
Perognathus parvus
Peromyscus maniculatus
Peromyscus truei
Ischyropoda furmani
Dipodomys ordii
Microdipodops megacephalus
Neotoma lepida
Onychomys leucogaster
Perognathus longimembris
Peromyscus maniculatus
Kleemania sp.
Citellus lateralis
Dipodomys microps
Dipodomys ordii
Eutamias minimus
°*Onychomys leucogaster* 9%
Perognathus formosus
Perognathus longimembris
Perognathus parvus
Peromyscus crinitus
Peromyscus maniculatus
Laelaps kochi
Dipodomys ordii
Eutamias minimus
Eutamias quadrivittatus
°*Microtus longicaudus* 6%
°*Microtus montanus* 13%
Microtus pennsylvanicus
Phenacomys intermedius
Laelaps multispinosus
Ondatra zibethicus
Peromyscus maniculatus
*Laelaps nuttalli*i
Peromyscus maniculatus
Laelaps incilis
Eutamias quadrivittatus
Microtus longicaudus
Microtus montanus

Peromyscus maniculatus
Leewenhoekia americana
Blarina sp. (probably *Sorex* sp.)
Peromyscus maniculatus
Scapanus sp. (probably *Sorex* sp.)
Listrophorus sp.
Dipodomys ordii
Perognathus formosus
Perognathus longimembris
Peromyscus maniculatus
Macrocheles sp.
Citellus armatus
Dipodomys ordii
Marmota flaviventris
°*Mus musculus* 5%
Onychomys torridus
Perognathus longimembris
Peromyscus maniculatus
Reithrodontomys megalotis
Thomomys bottae
Thomomys talpoides
Zapus princeps
Myobia sp.
Neotoma lepida
Myocoptes sp.
Peromyscus maniculatus
Reithrodontomys megalotis
Myonyssus montanus
Ochotona princeps
Odontacarus hirsutus
°*Mus musculus* 5%
°*Neotoma cinerea* 6%
Neotoma lepida
Odontacarus linsdalei
Dipodomys microps
Dipodomys ordii
Neotoma lepida
Perognathus formosus
Perognathus parvus
Peromyscus maniculatus
Odontacarus micheneri
Neotoma cinerea
°*Neotoma lepida* 7%
Onychomys torridus
Perognathus parvus
Sylvilagus sp.
Ornithonyssus aridus
Citellus leucurus
Ornithonyssus bacoti
Citellus townsendii
Dipodomys ordii
Eutamias minimus
Neotoma lepida
Perognathus parvus
Peromyscus boylii
Peromyscus crinitus
Peromyscus cremicus
Peromyscus maniculatus
°*Peromyscus truei* 10%
Rattus norvegicus
Ornithonyssus sylviarum
Marmota flaviventris
°*Sylvilagus nuttallii* 5%
Paraspinturnix globosus
Myotis sp.
Radfordia bachai
Dipodomys ordii
Radfordia lemnina
Peromyscus maniculatus
Radfordia subuliger
Peromyscus maniculatus
Reithrodontomys megalotis
Spinturnix orri
Antrozous pallidus
Steatonyssus antrozoi
Corynorhinus rafinesquii 6%
Trombicula allredi
Neotoma lepida
Trombicula arenicola
Citellus leucurus
Citellus spilosoma
Cynomys parvidens
Dipodomys merriami
°*Dipodomys microps* 5%
Dipodomys ordii
Neotoma lepida
°*Perognathus formosus* 20%
Perognathus longimembris
Perognathus parvus
Peromyscus maniculatus
Peromyscus truei
Reithrodontomys megalotis
Trombicula bakeri
Citellus armatus
Dipodomys ordii
Peromyscus maniculatus
Trombicula belkini
Citellus lateralis
Citellus leucurus
Clethrionomys gapperi
Dipodomys ordii
Peromyscus truei
Trombicula californica
Citellus armatus
Clethrionomys gapperi
Microtus longicaudus
Peromyscus maniculatus
Zapus princeps
Trombicula doremi
Perognathus longimembris
Dipodomys merriami
Dipodomys ordii
Trombicula esoensis
Peromyscus maniculatus
Trombicula harperi
Citellus armatus
Citellus lateralis
°*Clethrionomys gapperi* 6%
Eutamias minimus
Human
Marmota flaviventris
°*Microtus longicaudus* 5%
Microtus montanus
Neotoma lepida
°*Ochotona princeps* 26%
Onychomys leucogaster
Perognathus parvus
Peromyscus maniculatus
°*Zapus princeps* 6%
Trombicula hoplai
Citellus leucurus
Neotoma lepida
Perognathus apache
Perognathus parvus
Peromyscus truei
Trombicula jewetti
Peromyscus maniculatus
Trombicula kardosi

Eutamias umbrinus
Trombicula montanensis
Citellus lateralis
Cynomys leucurus
Peromyscus crinitus
Peromyscus truei
Peromyscus maniculatus
Trombicula myotis
Bat
Myotis californicus
Peromyscus maniculatus
Trombicula panamensis
Neotoma lepida
Peromyscus maniculatus
Trombicula potosina
Perognathus parvus
Neotoma lepida
Microtus longicaudus
Trombicula sargenti
Neotoma lepida
Trombicula subsignata
Reithrodontomys megalotis
Trombicula univari
Pipistrellus hesperus
Whartonia perplexa
Antrozous pallidus
Myotis californicus
Zumptiella bakeri
Citellus armatus
Eutamias quadrivittatus

TABLE 3. HOST-MITE RELATIONSHIPS IN UTAH.

Mites indicated with an asterisk are those which were found most frequently on the host. Where applicable, the order of those so marked is designated, number one being most common. Species not marked with an asterisk occurred about equally or with insufficient frequency on the host to warrant frequency designation. Names of hosts enclosed within parentheses are as designated by Hall and Kelson (1959).

Antrozous pallidus
Spinturnix orri
Whartonia perplexa
Bat
Trombicula myotis
Whartonia perplexa
Citellus armatus (= *Spermophilus armatus*)
Androlaelaps leviculus
Eulaelaps stabularis
Euschoengastia ericeticola
Euschoengastia sciuricola
Haemogamasus ambulans
°*Haemolaelaps glasgowi* 1
Hirstionyssus angustus
Hirstionyssus femuralis
°*Hirstionyssus invaginatus* 2
Hirstionyssus isabellinus
Hirstionyssus utahensis
Macrocheles sp.
Trombicula bakeri
Trombicula californica
Trombicula harperi
Zumptiella bakeri
Citellus lateralis (=*Spermophilus lateralis*)
Androlaelaps leviculus
Euschoengastia cordiremus
Euschoengastia ericeticola
Euschoengastia decipiens
Euschoengastia hoffmannae
Euschoengastia lacerta
Euschoengastia lutcodema
Euschoengastia sciuricola
Haemogamasus ambulans
Haemolaelaps casalis
°*Haemolaelaps glasgowi*
Hirstionyssus utahensis
Hypoaspis lubrica
Kleemania sp.
Trombicula belkini
Trombicula harperi
Trombicula montanensis
Citellus leucurus (=*Ammospermophilus leucurus*)
°*Haemolaelaps glasgowi*
Hirstionyssus incomptus
Hirstionyssus triacanthus
Ornithonyssus aridus
Trombicula arenicola
Trombicula belkini
Trombicula hoplai
Citellus richardsonii (=*Spermophilus richardsonii*)
Haemolaelaps glasgowi
Citellus spilosoma (=*Spermophilus spilosoma*)
Euschoengastia cynomyicola
Hypoaspis lubrica
Trombicula arenicola
Citellus townsendii (=*Spermophilus townsendii*)
Euschoengastia ericeticola
Haemolaelaps glasgowi
Ornithonyssus bacoti
Citellus tridecemlineatus (=*Spermophilus tridecemlineatus*)
°*Haemolaelaps glasgowi*
Hirstionyssus utahensis
Citellus variegatus (=*Spermophilus variegatus*)
Brevisterna utahensis
Euschoengastia sciuricola
°*Haemolaelaps glasgowi*
Hirstionyssus incomptus
Ischyropoda armatus
Clethrionomys gapperi
Haemogamasus ambulans
Trombicula belkini
Trombicula californica
Trombicula harperi
Corynorhinus rafinesquii (=*Corynorhinus townsendii*)
Eubrachylaelaps debilis
Steatonyssus antrozoi
Cynomys parvidens
Trombicula arenicola
Cynomys leucurus
°*Haemolaelaps glasgowi*
Trombicula montanensis
Dama hemionus
Euschoengastia radfordi
Dipodomys merriami

Brevisterna utahensis
Euschoengastia decipiens
Haemolaelaps casalis
°*Haemolaelaps glasgowi*
Hirstionyssus incomptus
Hirstionyssus triacanthus
Ischyropoda armatus
Trombicula arenicola
Trombicula doremi

Dipodomys microps
Euschoengastia cricetícola
Euschoengastia decipiens
Euschoengastia radfordi
Haemolaelaps glasgowi
Hirstionyssus incomptus
°*Hirstionyssus triacanthus*
Ischyropoda armatus
Kleemania sp.
Odontacarus linsdalei
Trombicula arenicola

Dipodomys ordii
Androlaelaps leviculus
Euschoengastia cricetícola
Euschoengastia decipiens
Euschoengastia radfordi
Haemogamasus ambulans
°*Haemolaelaps glasgowi* 2
Hirstionyssus hilli
°*Hirstionyssus incomptus* 1
Hirstionyssus neotomae
°*Hirstionyssus triacanthus* 3
Hirstionyssus utahensis
Ischyropoda armatus
Ischyropoda furmani
Kleemania sp.
Laelaps kochi
Listrophorus sp.
Macrocheles sp.
Odontacarus linsdalei
Ornithonyssus bacoti
Radfordia bachai
Trombicula arenicola
Trombicula bakeri
Trombicula belkini
Trombicula doremi

Erethizon epixanthum (= *Erethizon dorsatum*)
Euschoengastia decipiens
Euschoengastia radfordi
Ischyropoda armatus

Eutamias dorsalis
Hirstionyssus sp.

Eutamias minimus
Euschoengastia sciuricola
Haemolaelaps glasgowi
Hirstionyssus affinis
Hirstionyssus punctatus
Hirstionyssus utahensis
Kleemania sp.
Laelaps kochi
Ornithonyssus bacoti
Trombicula harperi

Eutamias quadrivittatus
Brevisterna montanus
Dermanyssus becki
Euschoengastia oregonensis
Haemogamasus pontiger
Haemolaelaps glasgowi
Hirstionyssus eutamiae
Hirstionyssus isabellinus
Hirstionyssus punctatus
°*Hirstionyssus utahensis*
Laelaps kochi
Laelaps incilis
Zumptiella bakeri

Eutamias umbrinus
Euschoengastia pomerantzi
Euschoengastia sciuricola
Gahrliepia americana
Haemogamasus ambulans
Trombicula kardosi

Glaucomys sabrinus
Haemogamasus ambulans
Hirstionyssus punctatus

Human
Trombicula harperi

Lepus californicus
Brevisterna utahensis
Dermanyssus becki
Eubrachylaelaps circularis
°*Euschoengastia decipiens*
Euschoengastia radfordi
Haemolaelaps glasgowi
Hirstionyssus triacanthus
Ischyropoda armatus

Marmota flaviventris
Dermanyssus becki
Euschoengastia hitcodema
Euschoengastia sciuricola
Haemolaelaps glasgowi
Macrocheles sp.
Ornithonyssus sylviarum
Trombicula harperi

Microdipodops megacephalus
Ischyropoda furmani

Microtus longicaudus
Eubrachylaelaps debilis
Euschoengastia oregonensis
Haemogamasus alaskensis
Haemogamasus ambulans
Haemogamasus liponyssoides
Haemogamasus longitarsus
Haemolaelaps glasgowi
Hirstionyssus incomptus
Hirstionyssus isabellinus
Laelaps kochi
Laelaps incilis
Trombicula californica
Trombicula harperi
Trombicula potosina

Microtus mexicanus
Haemolaelaps glasgowi

Microtus montanus
Haemogamasus ambulans
°*Haemolaelaps glasgowi* 1
Hirstionyssus isabellinus
°*Laelaps kochi* 2
Laelaps incilis
Trombicula harperi

Microtus pennsylvanicus
Haemolaelaps glasgowi
Hirstionyssus isabellinus
Laelaps kochi

Microtus sp.
Eulaelaps stabularis
Euschoengastia oregonensis
Haemogamasus ambulans
Haemogamasus liponyssoides
°*Haemolaelaps glasgowi*

Hirstionyssus isabellinus
Laelaps kochi
Laelaps incilis
Trombicula harperi
Mus musculus
Brevisterna utahensis
Haemogamasus ambulans
Haemolaelaps casalis
Haemolaelaps glasgowi
Hirstionyssus sp.
Hirstionyssus invaginatus
Macrocheles sp.
Odontacarus hirsutus
Mustela frenata
Hirstionyssus femuralis
Myotis californicus
Ischyropoda armatus
Trombicula myotis
Whartonia perplexa
Myotis sp.
Paraspinturnix globosus
Trombicula myotis
Neotoma albigula
Dermanyssus hecki
Neotoma cinerea
Brevisterna utahensis
Chatia ochotona
Haemogamasus ambulans
Haemolaelaps glasgowi
Hirstionyssus neotomae
Odontacarus hirsutus
Odontacarus linsdalei
Neotoma lepida
°*Brevisterna utahensis* 1
°*Dermanyssus hecki* 2
Eubrachylaelaps circularis
Eubrachylaelaps hollisteri
Euschoengastia cricetícola
Euschoengastia decipiens
Euschoengastia fasolla
Euschoengastia furmani
Euschoengastia lacerta
Euschoengastia lanceolata
Euschoengastia radfordi
Euchoengastia utahensis
Haemogamasus ambulans
Haemogamasus pontiger
Haemolaelaps casalis
Haemolaelaps glasgowi
Hirstionyssus bisetosus
Hirstionyssus femuralis
Hirstionyssus geomydis
Hirstionyssus hilli
Hirstionyssus incomptus
Hirstionyssus neotomae
Hirstionyssus triacanthus
Hirstionyssus utahensis
Ischyropoda furmani
Myobia sp.
Odontacarus hirsutus
Odontacarus linsdalei
°*Odontacarus micheneri* 3
Ornithonyssus bacoti
Trombicula allredi
Trombicula arenicola
Trombicula harperi
Trombicula hoplai
Trombicula panamensis
Trombicula potosina
Trombicula sargenti
Ochotona princeps
Chatia setosa
Euschoengastia cricetícola
Euschoengastia hoffmannae
Euschoengastia lanei
Euschoengastia oregonensis
Euschoengastia sciuricola
Euschoengastia soricinus
Haemogamasus alaskensis
Haemogamasus ambulans
Haemolaelaps glasgowi
Hirstionyssus isabellinus
Hirstionyssus longichelae
Myonyssus montanus
°*Trombicula harperi*
Ondatra zibethicus
Laelaps multispinosus
Onychomys leucogaster
Androlaelaps leviculus
Eubrachylaelaps crowei
Haemogamasus ambulans
Haemolaelaps geomys
°*Haemolaelaps glasgowi* 1
Hirstionyssus hilli
°*Ischyropoda armatus* 2
Ischyropoda furmani
Kleemania sp.
Trombicula harperi
Onychomys torridus
Haemolaelaps glasgowi
Hirstionyssus isabellinus
Ischyropoda armatus
Macrocheles sp.
Odontacarus micheneri
Perognathus apache
Androlaelaps leviculus
Trombicula hoplai
Perognathus flavus
Hirstionyssus hilli
Ischyropoda armatus
Perognathus formosus
Androlaelaps leviculus
Brevisterna utahensis
Euschoengastia decipiens
Euschoengastia cricetícola
Euschoengastia utahensis
Haemolaelaps glasgowi
Hirstionyssus affinis
Hirstionyssus triacanthus
Ischyropoda armatus
Kleemania sp.
Listrophorus sp.
Odontacarus linsdalei
°*Trombicula arenicola*
Perognathus longimembris
Bernia marita
Eubrachylaelaps circularis
Euschoengastia decipiens
Haemolaelaps glasgowi
Hirstionyssus hilli
Hirstionyssus incomptus
Hirstionyssus triacanthus
Hirstionyssus utahensis
Ischyropoda armatus
Ischyropoda furmani
Kleemania sp.
Listrophorus sp.
Macrocheles sp.

Trombicula arenicola
Trombicula doremi
Perognathus parvus
Androlaelaps leviculus
Eubrachylaelaps circularis
Eubrachylaelaps hollisteri
Euschoengastia cordiremus
Euschoengastia decipiens
Euschoengastia oregonensis
Haemogamasus ambulans
°*Haemolaelaps glasgowi*
Hirstionyssus hilli
Hirstionyssus incomptus
Hirstionyssus neotomae
Ischyropoda armatus
Kleemania sp.
Odontacarus linsdalei
Odontacarus micheneri
Ornithonyssus bacoti
Trombicula arenicola
Trombicula harperi
Trombicula hoplai
Trombicula potosina
Perognathus sp.
Eubrachylaelaps crowei
Ischyropoda furmani
Trombicula doremi
Peromyscus boylii
Brevisterna utahensis
Dermanyssus becki
Eubrachylaelaps circularis
Euschoengastia ciceticola
Haemogamasus pontiger
Haemolaelaps casalis
Haemolaelaps glasgowi
Ornithonyssus bacoti
Peromyscus crinitus
Androlaelaps leviculus
Brevisterna utahensis
Dermanyssus becki
Eubrachylaelaps circularis
Eubrachylaelaps debilis
°*Eubrachylaelaps hollisteri*
Euschoengastia decipiens
Euschoengastia radfordi
Haemolaelaps casalis
Haemolaelaps glasgowi
Hirstionyssus incomptus
Hirstionyssus triacanthus
Hirstionyssus utahensis
Kleemania sp.
Ornithonyssus bacoti
Trombicula montanensis
Peromyscus cremicus
Brevistrena utahensis
Dermanyssus becki
Eubrachylaelaps circularis
Eubrachylaelaps debilis
Eubrachylaelaps hollisteri
Euschoengastia ciceticola
Euschoengastia decipiens
Euschoengastia lanceolata
Euschoengastia radfordi
Haemogamasus pontiger
Haemolaelaps glasgowi
Hirstionyssus femuralis
Hirstionyssus hilli
Hirstionyssus incomptus
Hirstionyssus triacanthus
Ornithonyssus bacoti
Peromyscus maniculatus
Androlaelaps leviculus
Brevisterna utahensis
Chatia ochotona
Chatia sctosa
Dermanyssus becki
°*Eubrachylaelaps circularis* 2
Eubrachylaelaps debilis
Eubrachylaelaps hollisteri
Eulaelaps stabularis
Euschoengastia cordiremus
°*Euschoengastia ciceticola* 2
Euschoengastia decipiens
Euschoengastia lanei
Euschoengastia luteodema
Euschoengastia obesa
Euschoengastia oregonensis
Euschoengastia pomerantzi
Euschoengastia radfordi
Euschoengastia rotunda
Euschoengastia sciuricola
Haemogamasus alaskensis
Haemogamasus ambulans
Haemogamasus longitarsus
Haemogamasus pontiger
Haemolaelaps casalis
°*Haemolaelaps glasgowi* 1
Hirstionyssus hilli
Hirstionyssus incomptus
Hirstionyssus isabellinus
Hirstionyssus neotomae
Hirstionyssus punctatus
Hirstionyssus tarsalis
Hirstionyssus triacanthus
°*Hirstionyssus utahensis* 2
Hypoaspis gurabensis
Hypoaspis lubrica
Ischyropoda armatus
Ischyropoda furmani
Kleemania sp.
Laelaps multispinosus
Laelaps nuttallii
Laelaps incilis
Leeuwenhoekia americana
Listrophorus sp.
Macrocheles sp.
Myocoptes sp.
Odontacarus linsdalei
°*Ornithonyssus bacoti* 3
Radfordia lemnina
Radfordia subuliger
Trombicula arenicola
Trombicula bakeri
Trombicula californica
Trombicula esoensis
Trombicula harperi
Trombicula jewetti
Trombicula montanensis
Trombicula myotis
Trombicula panamensis
Peromyscus truei
Brevisterna utahensis
Dermanyssus becki
°*Eubrachylaelaps circularis* 1
Eubrachylaelaps debilis
Eubrachylaelaps hollisteri
Euschoengastia ciceticola
Euschoengastia decipiens

Euschoengastia pomerantzi
Haemogamasus ambulans
Haemolaelaps casalis
°*Haemolaelaps glasgowi* 2
Hirstionyssus affinis
Hirstionyssus neotomae
Hirstionyssus utahensis
Ischyropoda armatus
°*Ornithonyssus bacoti* 2
Trombicula arenicola
Trombicula belkini
Trombicula hoplai
Trombicula montanensis
Peromyscus sp.
Haemogamasus alaskensis
Phenacomys intermedius
Hirstionyssus isabellinus
Laelaps kochi
Pipistrellus hesperus
Trombicula univari
Rattus norvegicus
Eulaelaps stabularis
Haemolaelaps casalis
°*Haemolaelaps glasgowi*
Hirstionyssus incomptus
Hirstionyssus triacanthus
Hypoaspis lubrica
°*Onithonyssus bacoti*
Reithrodontomys megalotis
Eubrachylaelaps debilis
Euschoengastia cricetícola
Euschoengastia lanei
Euschoengastia radfordi
Euschoengastia sciuricola
°*Haemolaelaps glasgowi*
Hirstionyssus cutamiae
Hirstionyssus incomptus
Hirstionyssus isabellinus
Hirstionyssus triacanthus
Hirstionyssus utahensis
Macrocheles sp.
Myocoptes sp.
Radfordia subuliger
Trombicula arenicola
Trombicula subsignata
Sciurus aberti
Hirstionyssus torus
Sorex obscurus (=*Sorex vagrans*)
Euschoengastia oregonensis
Sorex palustris
Hirstionyssus palustris
Spilogale gracilis
Hirstionyssus staffordi
Sylvilagus audubonii
Eubrachylaelaps circularis
Euschoengastia decipiens
Haemolaelaps glasgowi
Sylvilagus idahoensis
Euschoengastia decipiens
Euschoengastia radfordi
Sylvilagus nuttallii
Euschoengastia decipiens
Ornithonyssus sylviarum
Sylvilagus sp.
Odontacarus micheneri
Tamiasciurus hudsonicus
Euschoengastia sciuricola
Haemogamasus ambulans
Haemolaelaps glasgowi
Thomomys bottae (=*Thomomys umbrinus*)
Haemogamasus ambulans
°*Haemolaelaps casalis*
Haemolaelaps glasgowi
°*Hirstionyssus femuralis*
Hypoaspis lubrica
Macrocheles sp.
Thomomys talpoides
°*Haemogamasus ambulans*
Haemogamasus longitarsus
Haemolaelaps casalis
Haemolaelaps glasgowi
Hirstionyssus femuralis
Hirstionyssus invaginatus
Hirstionyssus isabellinus
°*Hirstionyssus longichelae*
Hirstionyssus neotomae
Hirstionyssus thomomys
Hirstionyssus utahensis
Hypoaspis gurabensis
Macrocheles sp.
Zapus princeps
Haemogamasus alaskensis
°*Haemogamasus ambulans*
Haemolaelaps glasgowi
Macrocheles sp.
Trombicula californica
°*Trombicula harperi*

DISCUSSION

More than 9,000 small mammals representing 94 species of 51 genera were examined for ectoparasites. Approximately 13,000 mites were found on 4,015 of those examined. These, plus other previously listed records for Utah, represent 111 species of 34 genera of mites which include 12 new species in three genera, one genus being new.

During the sixteen-year period covered by this report, numerous individuals were involved with the collection of specimens. Even though standardized techniques were used, there likely was considerable variation in the efficiency of ectoparasite retrieval. Consequently, the incidence of ectoparasites as shown in Table I is relative only to the efficiency of our techniques. Hosts were collected by different methods, e.g., live-trapping, shooting, etc. and in almost all cases were examined in the field under varying conditions of weather, pressure of time, and lack of adequate facilities. It is likely that some ectoparasites were lost or overlooked, particularly those

requiring special techniques for their recovery. Nevertheless, over a period of years involving large numbers of specimens, we expect that each of the mite taxa would have been taken at least once.

The validity of host identification may be questionable in some instances, although for the most part identifications were made by a qualified mammalogist in the field, or representative specimens were returned to the reference museum at Brigham Young University for comparison and verification.

As shown in the listing of mite-host relationships (Table 2), the variety of hosts from which mites of a particular species were recovered may be correlated with the numbers of animals examined. For example, we examined more mice belonging to *Peromyscus maniculatus* than of any other species, and mites of more species were found on this mouse than on any other mammal studied. We assume that mites of almost any species occasionally are accidental symbionts of host animals living in the same habitat. Examination of large numbers of hosts increases the potential of finding such infestations. There is a tendency for host preference, and perhaps even for host specificity in some cases, whereas mites of some species are widely distributed geographically and occur on a variety of animals. For example, *Haemolaelaps glasgowi* is a widely distributed species and occurs on the greatest variety of mammals in Utah. This distribution and host relationship apparently is typical for this most cosmopolitan species.

Other surveys may reveal a frequency of occurrence of mites of a particular species different from that indicated by us (Table 3). We assume that mites of all species normally associated with a particular host have an equal opportunity of infesting that host, but the seasonal activity of different species may vary. Mites of one species may be more common on a host in summer, whereas those of another species may be more common in winter. In our field activities we collected the year round, but most mammals were taken in late spring, summer and early autumn.

Even though our data on mite-host relationships, relative abundance, frequency of occurrence and seasonal and geographic distribution may vary from other surveys, the information presented here should serve as a basis for further studies directed at specific localities or species. More work needs to be done on mammals that have been taken only in few numbers or only at certain times of the year.

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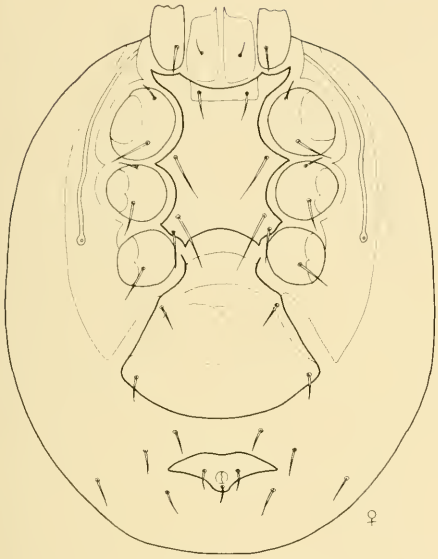
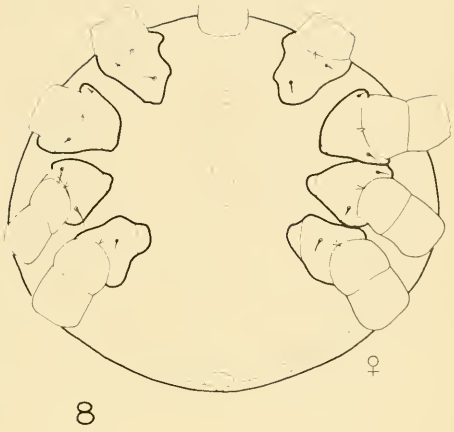
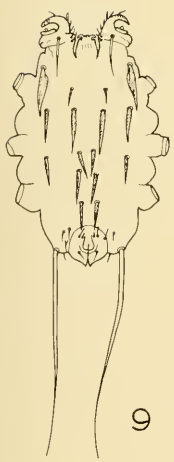
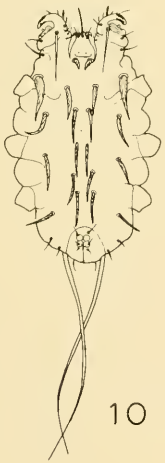
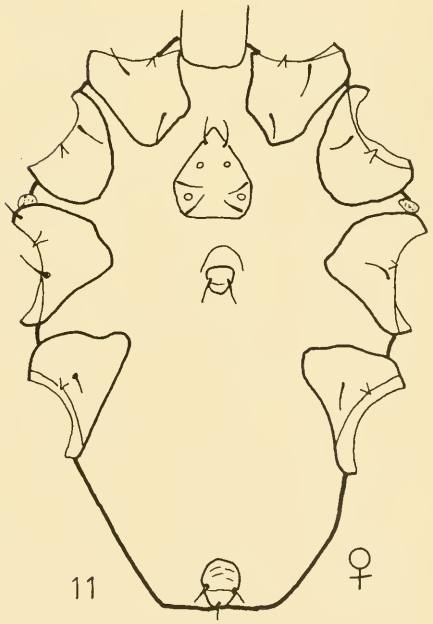


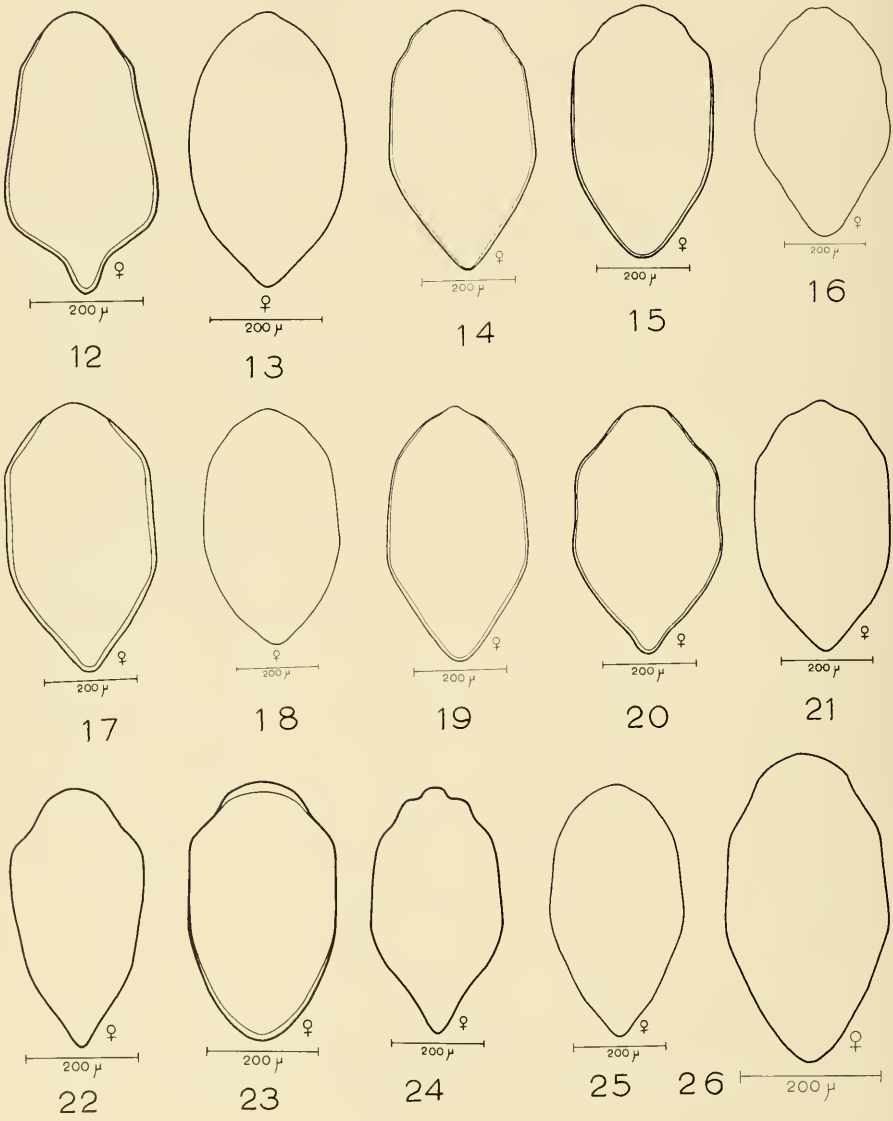




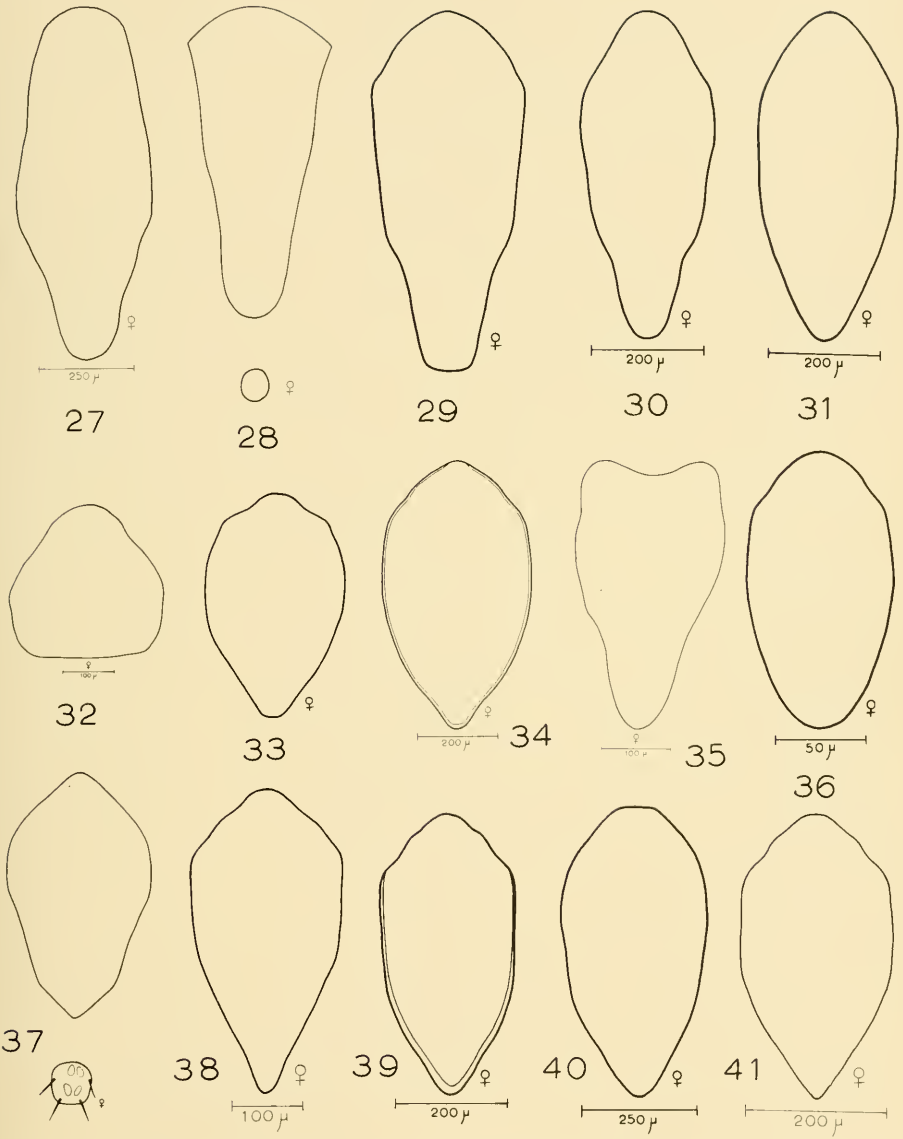




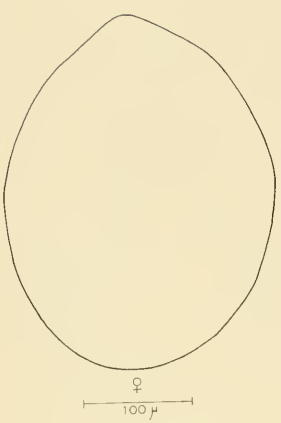
Figs. 7-11. 7, Pachylaelaptidae ventral; 8. *Paraspinturnix globus* ventral; 9, *Radfordia subliger* dorsal; 10, *Radfordia lemnina* dorsal; 11, *Spinturnix orri,* ventral.



Figs. 12-26. Dorsal plates of *Hirstionyssus*. 12, *staffordi*; 13, *tarsalis*; 14, *affinis*; 15, *palustris*; 16, *punctatus*; 17, *invaginatus*; 18, *invaginatus* variant; 19, *eutamiae*; 20, *utahensis*; 21, *angustus*; 22, *femuralis*; 23, *longichelae*; 24, *thomomys*; 25, *torus*; 26, *neotomae*.



Figs. 27-41. Dorsal plates. 27, *Dermanyssus becki;* 28, *D. sanguineus;* 29, *D. gallinae;* 30, *Ornithonyssus sylviarum;* 31, *O. sylviarum* variant; 32, *Steatonyssus antrozoi* anterior plate; 33, *Hirstionyssus hilli;* 34, *H. isabellinus;* 35, *S. antrozoi* posterior plate; 36, *H. bisetosus;* 37, *O. aridus;* 38, *H. triacanthus;* 39, *H. incomptus;* 40, *Ichoronyssus robustipes;* 41, *H. hilli* variant.



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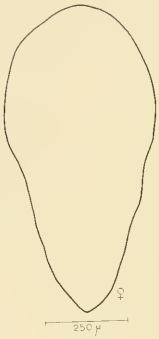

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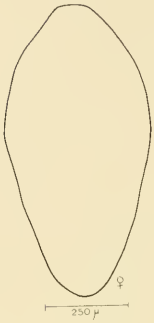

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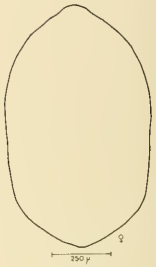

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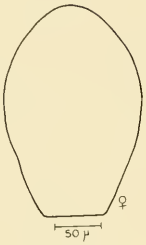

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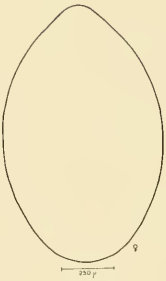

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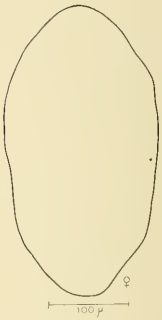

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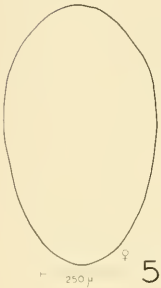

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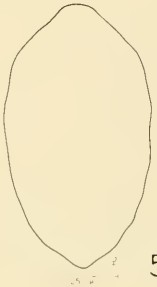

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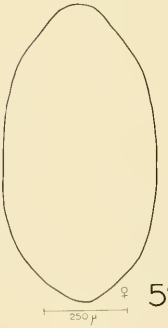

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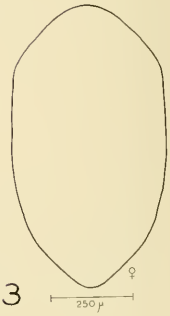

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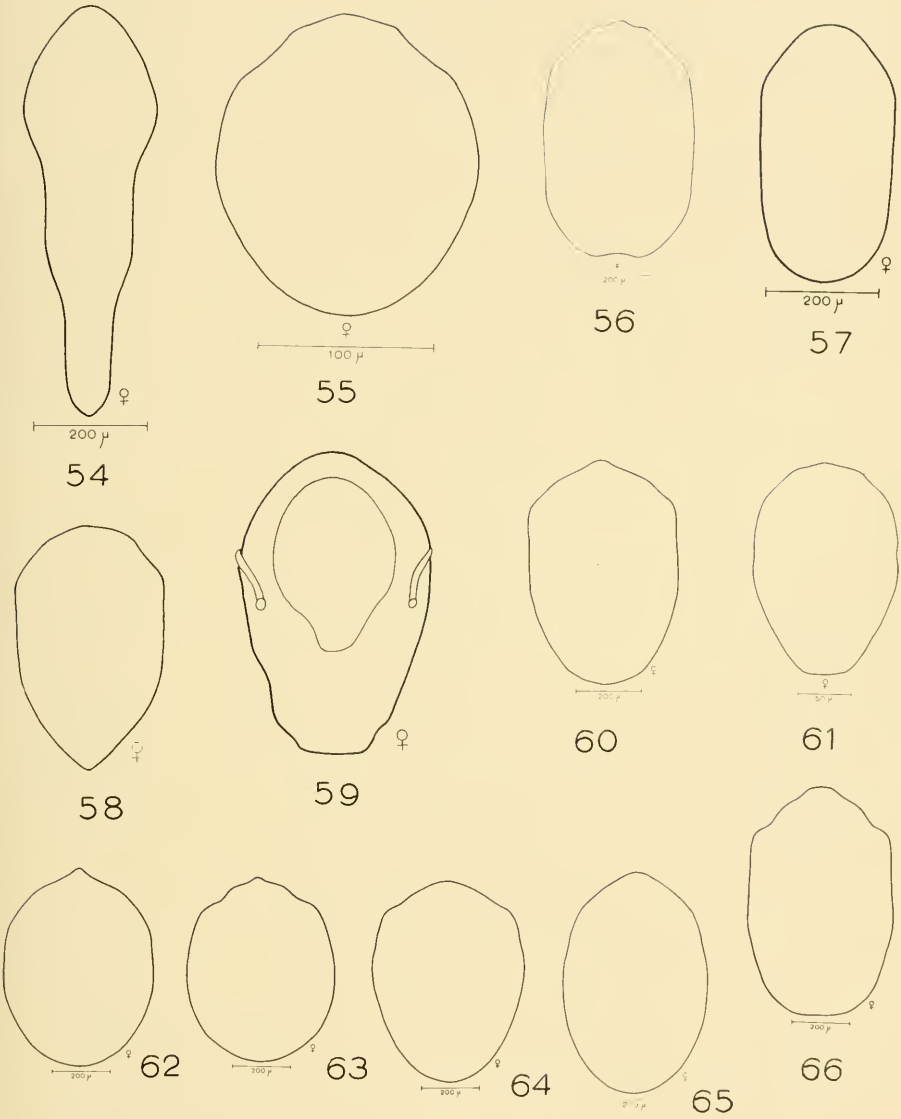
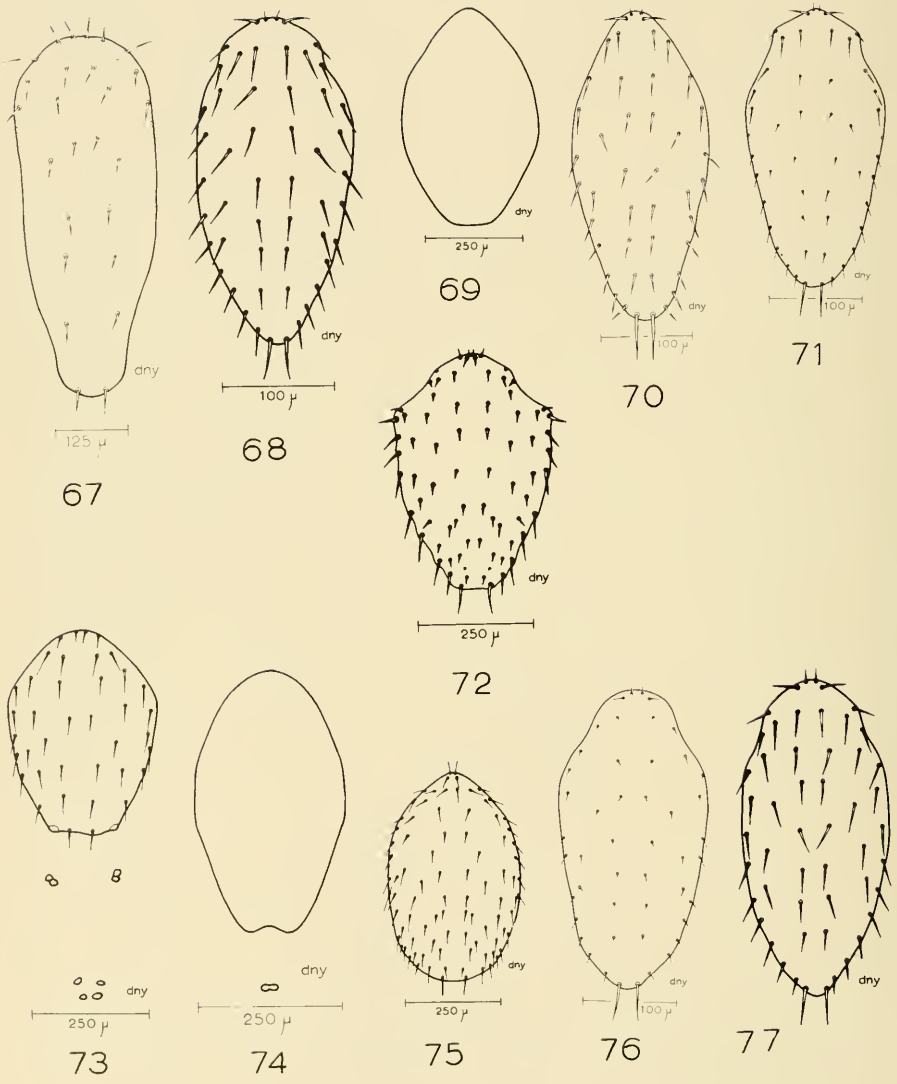
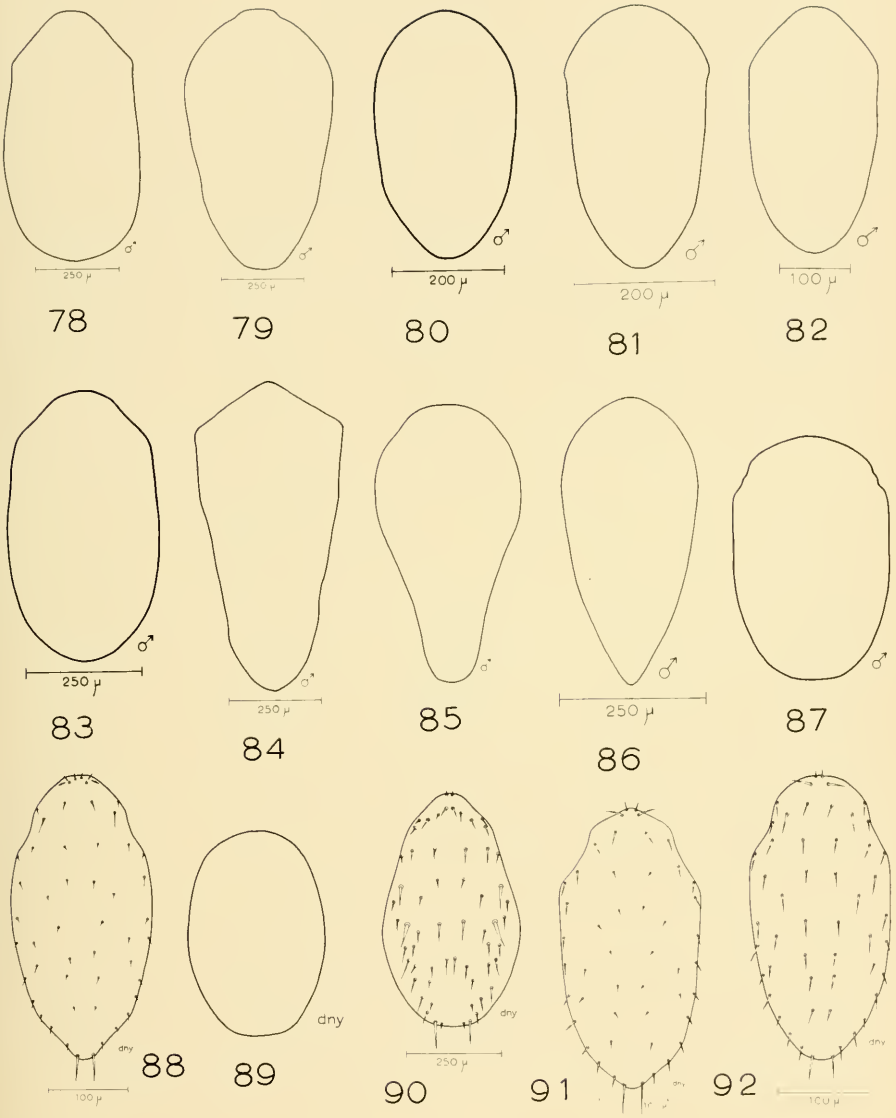
Figs. 42-53. Dorsal plates. 42, *Ischyropoda armatus;* 43, *Brevisterna montanus;* 44, *B. utahensis;* 45, *Haemogamasus alaskensis;* 46, *Zumpticlla bakeri;* 47, *I. furmani;* 48, *H. liponyssoides;* 49, *H. ambulans* form B; 50, *H. pontiger;* 51, *H. ambulans* form A; 52, *H. ambulans* form C; 53, *H. ambulans* form D.



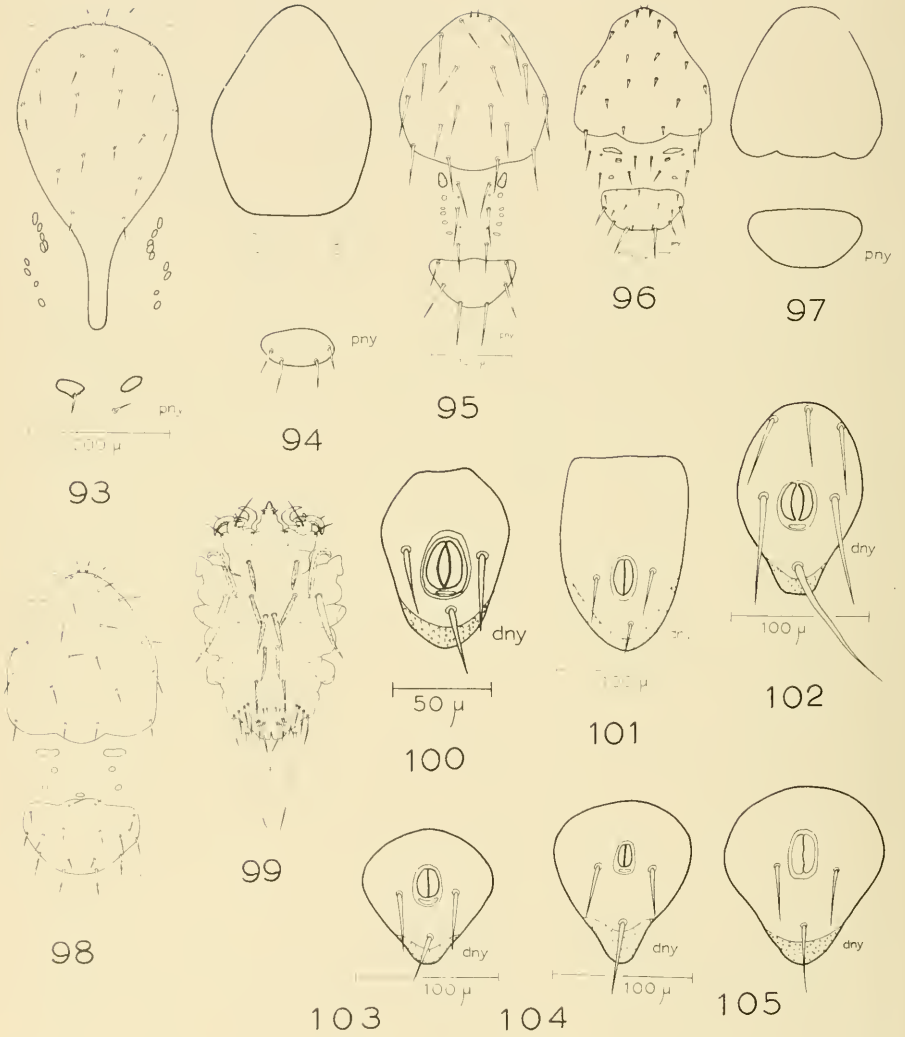
Figs. 54-66. Dorsal plates. 54, *Ornithonyssus bacoti*; 55, *Laelaps kochi*; 56, *L. multispinosus*; 57, *Hypoaspis lubrica*; 58, *H. gurabensis*; 59, *Spinturnix orri*; 60, *Eubrachylaelaps hollisteri*; 61, *L. incilis*; 62, *E. crowei*; 63, *E. circularis*; 64 *E. debilis*; 65, *Haemolaelaps casalis*; 66, *H. glasgowi*.



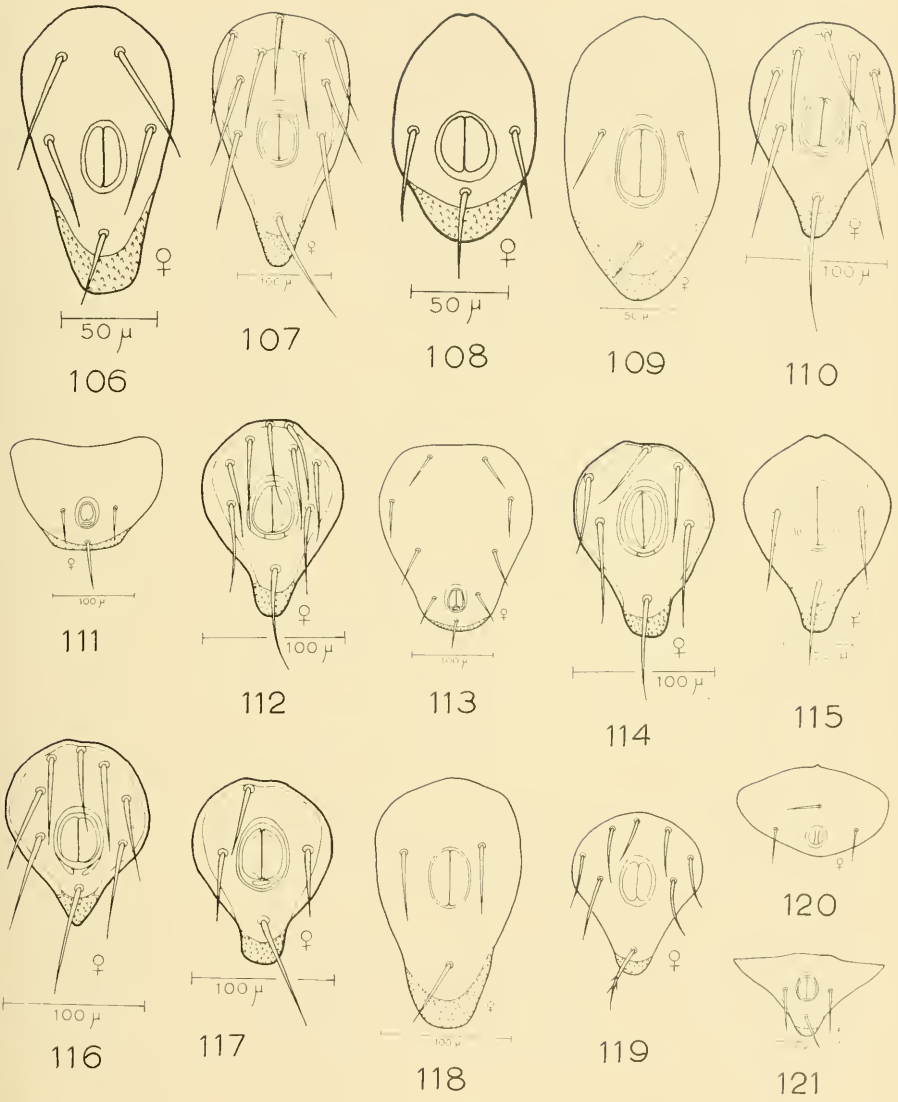
Figs. 67-77. Dorsal plates. 67, *Dermanyssus hecki*; 68, *Hirstionyssus bisetosus*; 69, *Ischyropoda armatus*; 70, *H. thomomys*; 71. *H. femuralis*; 72, *Laelaps kochi*; 73, *Brevisterna utahensis*; 74 *I. furmani*; 75, *Haemolaelaps glasgowi*; 76, *Hirstionyssus torus*; 77. *H. neotomae*.



Figs. 78-92. Dorsal plates. 78. *Brevisterna utahensis;* 79, *Haemogamasus ambulans* form B; 80. *Hirstionyssus thomomys;* 81. *H. neotomae;* 82, *H. neotomae* variant A; 83, *Ichoronyssus robustipes;* 84. *Dermanyssus hecki;* 85, *Ornithonyssus aridus;* 86, *O. bacoti;* 87, *Eubrachylaelaps circularis;* 88, *Hirstionyssus utahensis;* 89, *E. circularis;* 90, *Laelaps multispinosus;* 91, *Hirstionyssus isabellinus;* 92. *H. incomptus.*

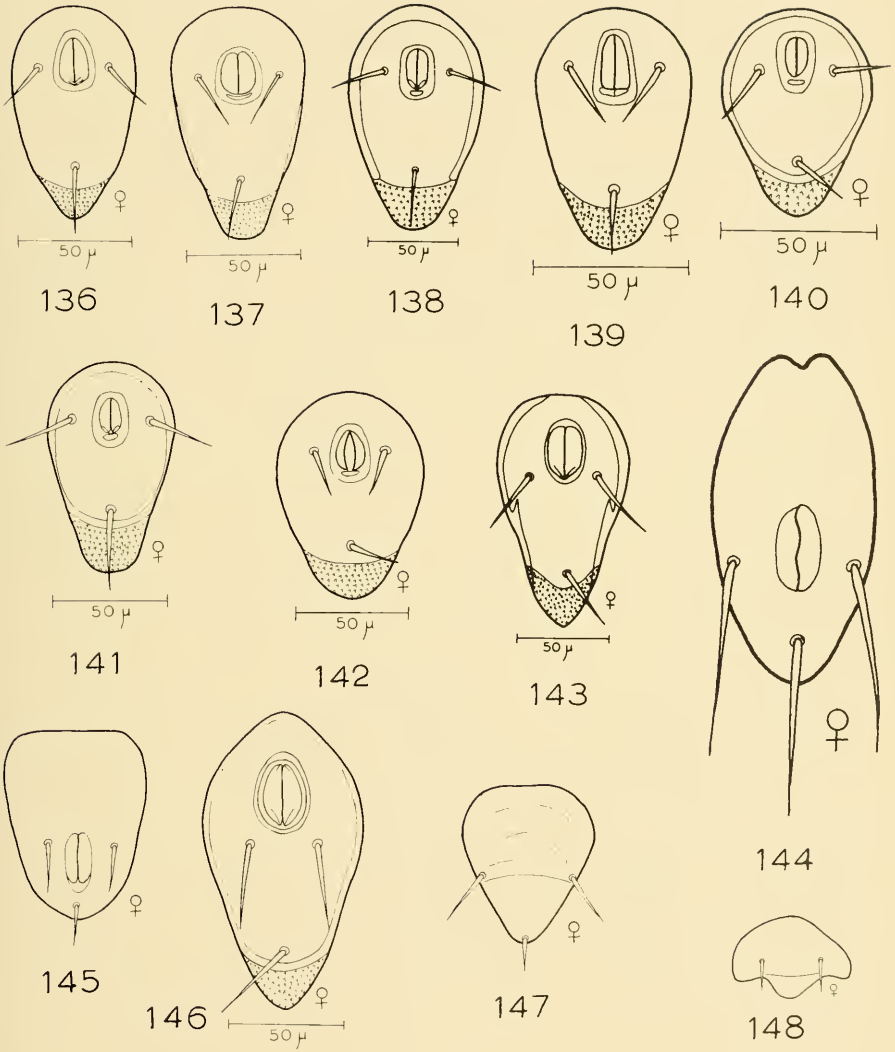


Figs. 93-105. Dorsal plates: 93, *Dermanyssus becki;* 94, *Ornithonyssus aridus;* 95, *O. bacoti;* 96, *Laelaps kochi;* 97, *Eubrachylaelaps circularis;* 98, *Haemolaelaps glasgowi.* 99. *Radfordia bachai* dorsal. Anal plates: 100, *Ischyropoda armatus;* 101, *D. becki;* 102, *Haemogamasus alaskensis;* 103, *Haemolaelaps casalis;* 104, *H. glasgowi;* 105, *E. circularis.*

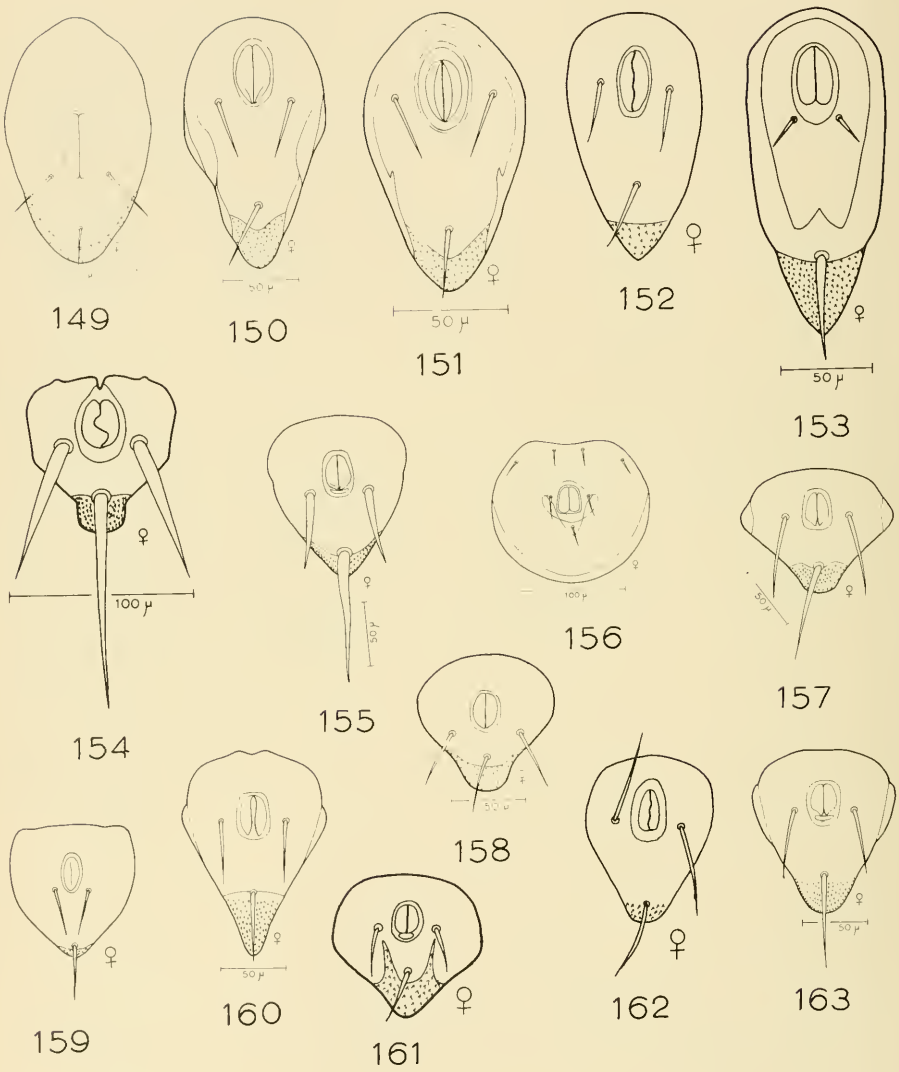


Figs. 106-121. Anal plates. 106, *Ischyropoda armatus;* 107, *Haemogamasus liponyssoides;* 108, *Ischyropoda furmani;* 109, *Brevisterna utahensis;* 110, *H. alaskensis;* 111, *Myonyssus montanus;* 112. *H. ambulans* form B; 113, *Macrocheles* sp.; 114, *H. ambulans* form C; 115, *H. pontiger;* 116. *H. ambulans* form A; 117. *H. ambulans* form D; 118, *B. montanus;* 119, *H. longitarsus;* 120. *Zumptiella bakeri;* 121. *Eulaelaps stabularis.*

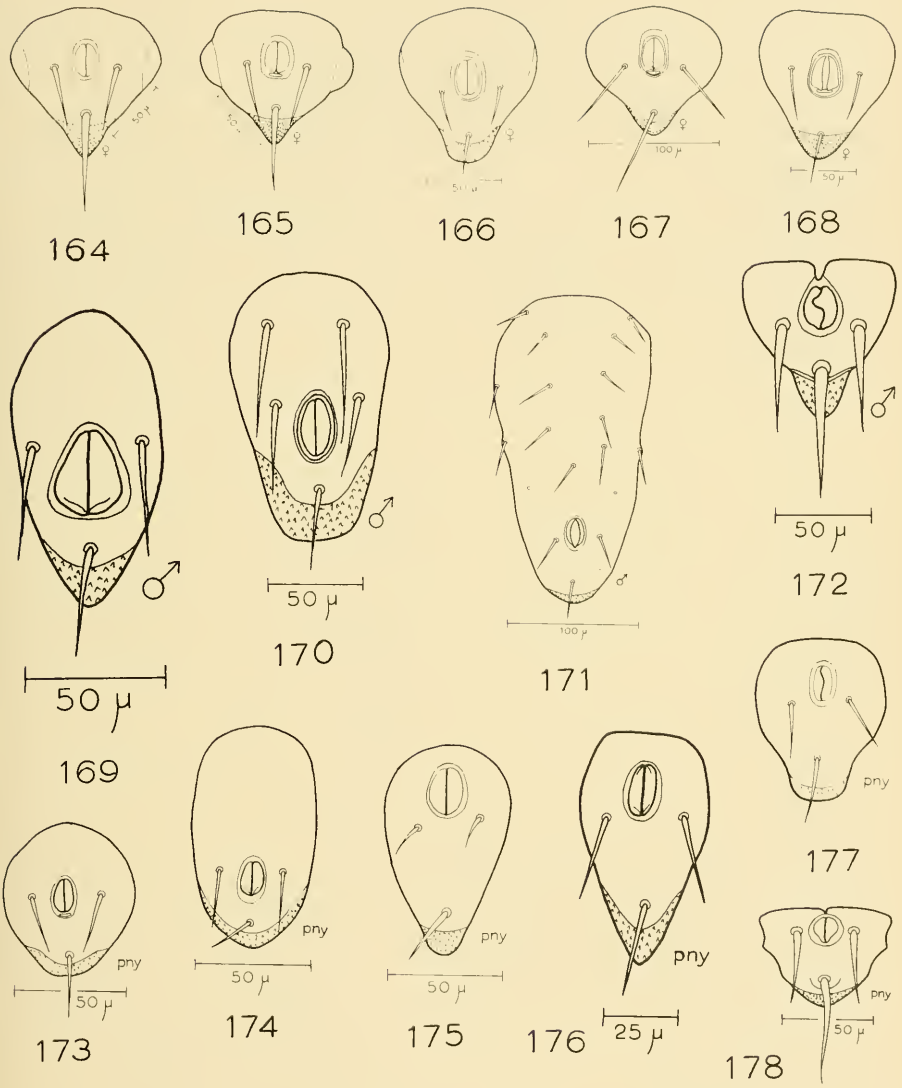
Figs. 122-135. Anal plates of *Hirstionyssus*. 122, *staffordi;* 123, *tarsalis;* 124, *affinis;* 125, *punctatus;* 126, *longichelae;* 127, *invaginatus* variant; 128, *eutamiae;* 129, *utahensis;* 130, *invaginatus,* 131, *palustris;* 132, *angustus;* 133, *thomomys;* 134, *torus;* 135, *femuralis.*



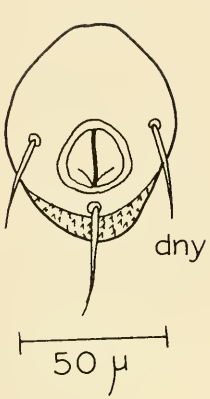
Figs. 136-148. Anal plates. 136. *Hirstionyssus neotomae;* 137. *H. hisctosus;* 138, *H. isabellinus;* 139, *H. hilli;* 140. *H. hilli* variant; 141. *H. triacanthus;* 142, *H. incomptus;* 143, *Ichoronyssus robustipes;* 144, *Dermanyssus sanguineus;* 145. *D. gallinae;* 146, *Ornithonyssus bacoti;* 147, *Spinturnix orri;* 148, *Paraspinturnix globosus.*



Figs. 149-163. Anal plates. 149, *Dermanyssus hecki;* 150. *Steatonyssus antrozoi;* 151, *Ornithonyssus sylviarum;* 152, *O. aridus;* 153, *Laelaps multispinosus;* 154, *L. kochi;* 155, *L. incilis;* 156. *Kleemania* sp.; 157. *Eubrachylaelaps crowei;* 158, *Androlaelaps leviculus;* 159, *L. nuttalli;* 160. *E. hollisteri;* 161, *Hypoaspis gurabensis;* 162. *Haemolaelaps geomys;* 163, *E. debilis.*



Figs. 164-178. Anal plates. 164, 165, *Eubrachylaelaps circularis;* 166, *Hypoaspis lubrica;* 167, *Haemolaelaps glasgowi;* 168, *H. casalis;* 169, *Ischyropoda furmani;* 170, *I. armatus;* 171, *Ichoronyssus robustipes;* 172, *Laelaps kochi;* 173, *H. glasgowi;* 174, *Dermanyssus hecki;* 175, *L. multispinosus;* 176, *Ornithonyssus bacoti;* 177, *E. circularis;* 178, *L. kochi.*



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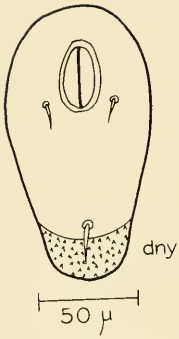

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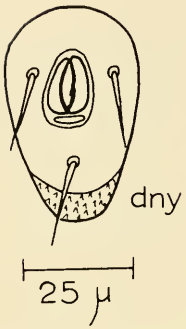

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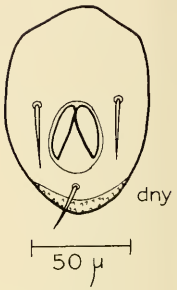

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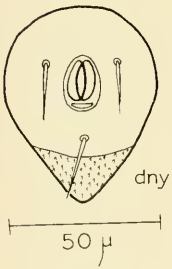

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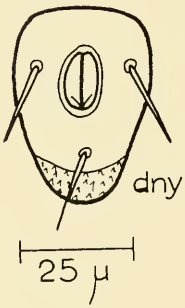

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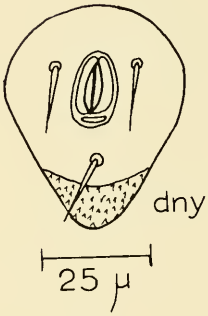

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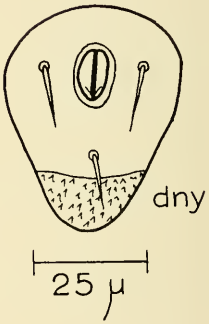

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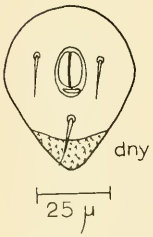

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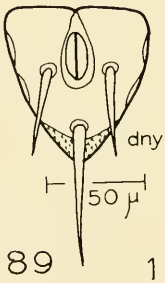

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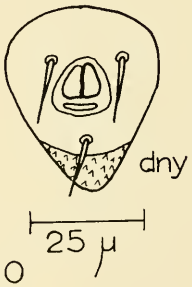

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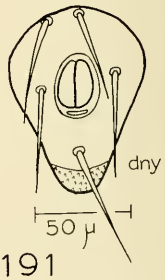

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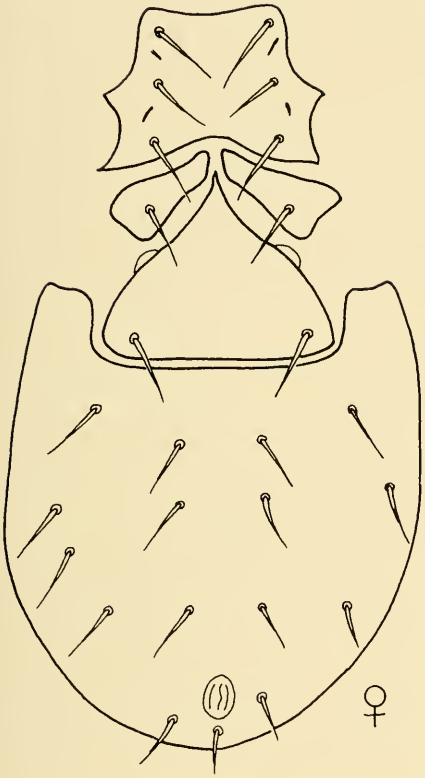
Figs. 179-191. Anal plates. 179, *Ischyropoda furmani;* 180, *Laelaps multispinosus;* 181. *Hirstionyssus neotomae;* 182, *Brevisterna utahensis;* 183. *H. isabellinus;* 184, *H. bisetosus;* 185, *H. torus;* 186, *H. incomptus;* 187. *H. utahensis;* 188, *H. thomomys;* 189, *L. kochi;* 190, *H. femuralis;* 191, *Haemogamasus ambulans* form B.



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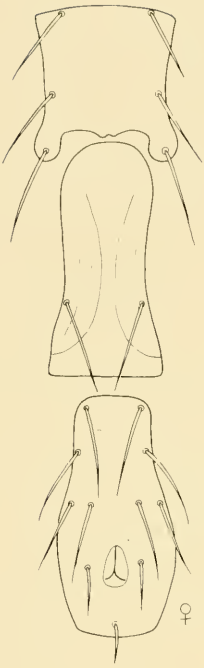

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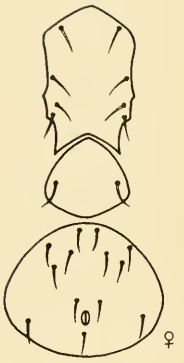

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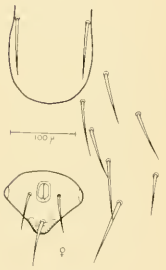

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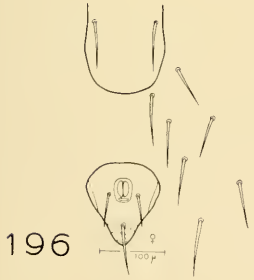

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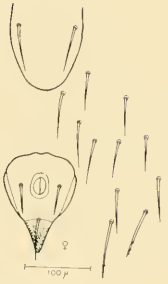

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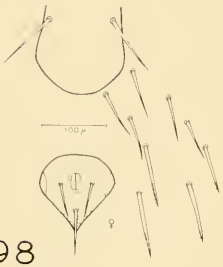
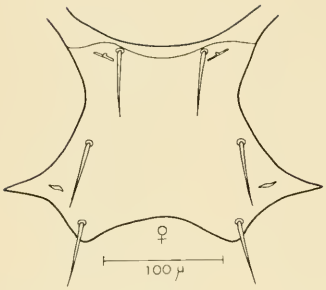


198

Figs. 192-198. Ventral plates: 192, Parasitidae; 193, Phytoseiidae; 194, Gamasolaelaptidae. Ventral setae arrangement: 195, *Eubrachylaelaps crowei*; 196, *E. debilis*; 197, *E. hollisteri*; 198, *E. circularis*.



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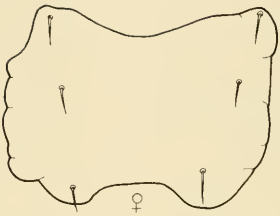

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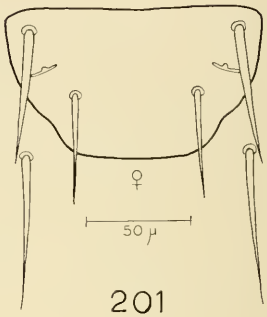

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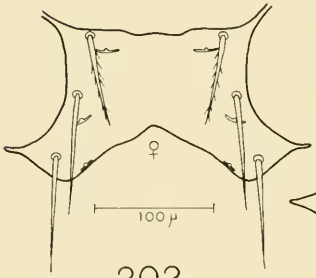

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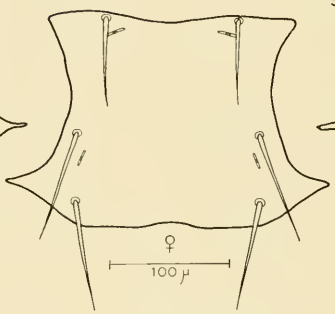

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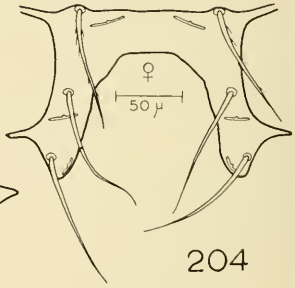

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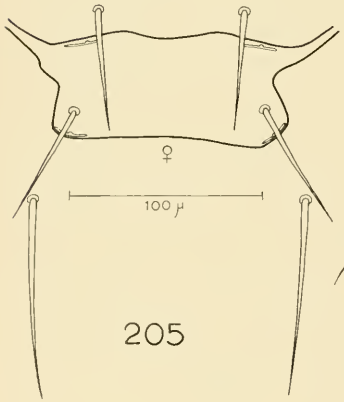

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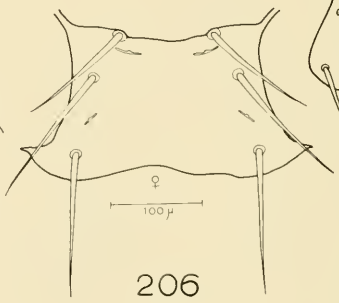

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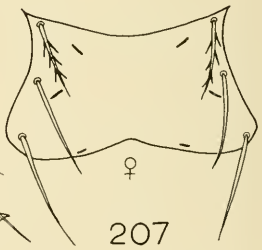
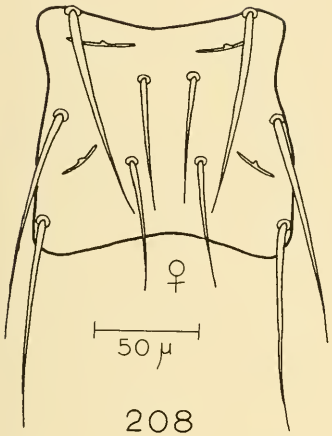


207

Figs. 199-207. Sternal plates. 199, *Macrocheles* sp.; 200. *Zumptiella bakeri;* 201, *Brevisterna montanus;* 202, *Haemogamasus ambulans* form A; 203, *Eulaelaps stabularis;* 204, *H. pontiger;* 205. *B. utahensis;* 206, *H. liponyssoides;* 207, *H. longitarsus.*



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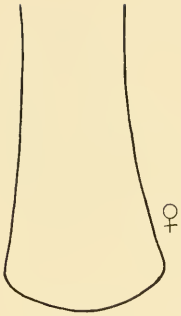

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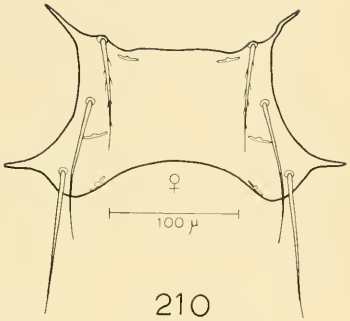

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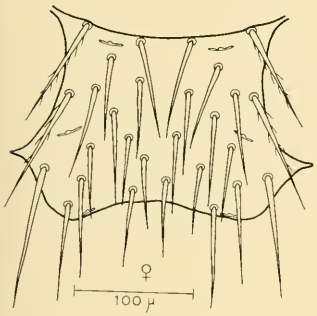

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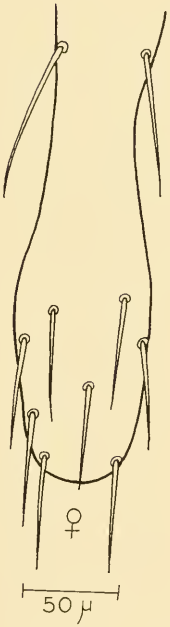

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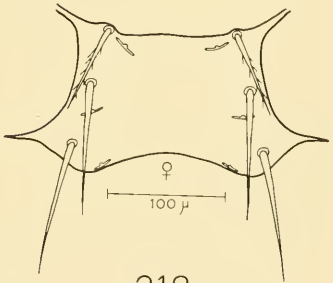

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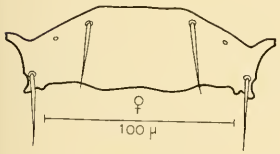

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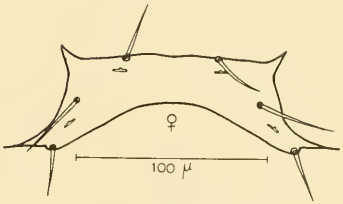
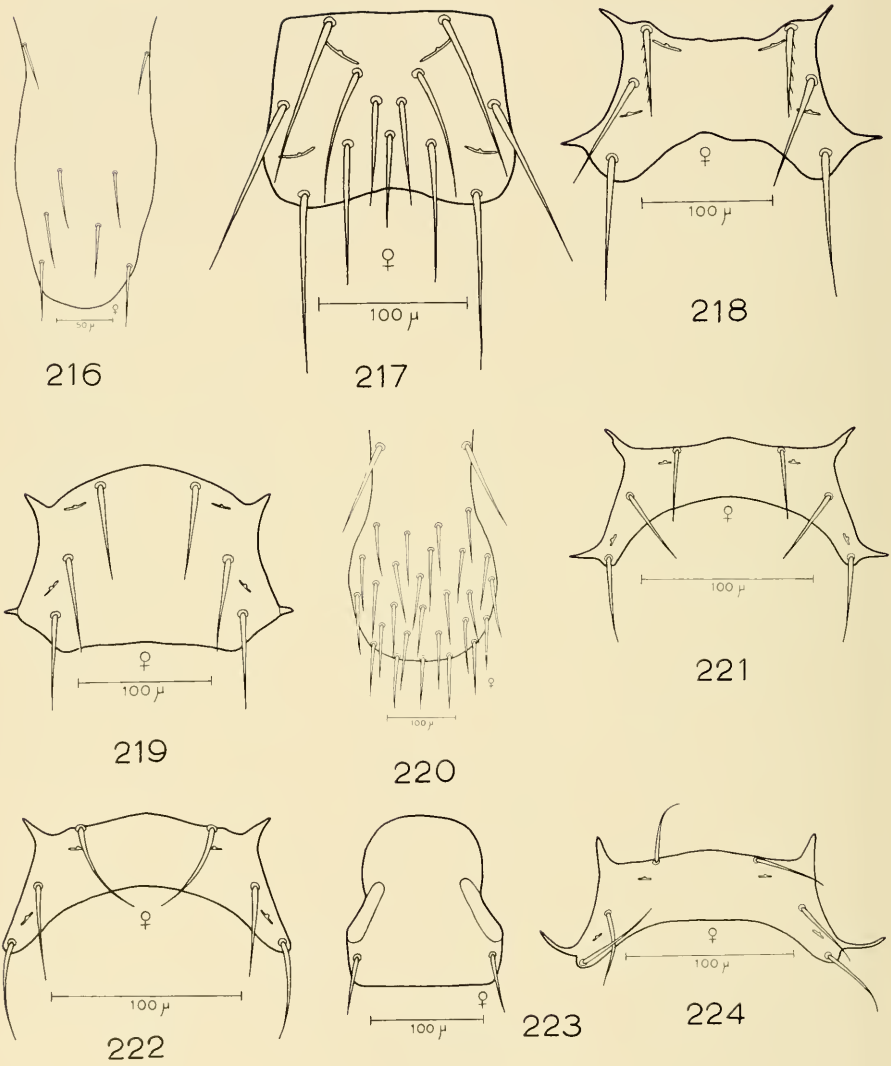
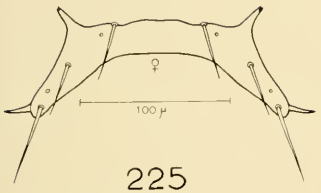


215

Figs. 208-215. Sternal plates: 208, *Ischyropoda furmani*; 210, *Haemogamasus ambulans* form C; 211, *H. alaskensis*; 212. *H. ambulans* form B; 213, *Hirstionyssus staffordi*; 215, *H. tarsalis*. Genitoventral plates: 209, *Zumptiella bakeri*; 214. *I. furmani*.



Figs. 216-224. Sternal plates: 217, *Ischyropoda armatus;* 218. *Haemogamasus ambulans* form D; 219, *Myonyssus montanus;* 221, *Hirstionyssus affinis;* 222, *H. palustris;* 224, *H. punctatus.* Genitoventral plates: 216. *Brevisterna utahensis;* 220. *Haemogamasus liponyssoides,* 223. *Macrocheles* sp.



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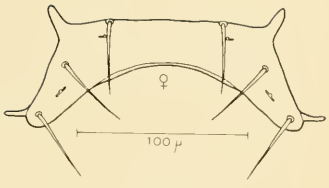

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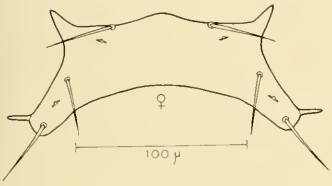

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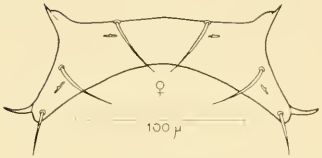

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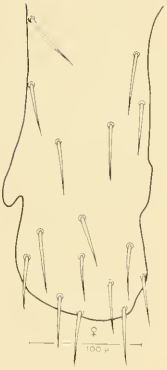

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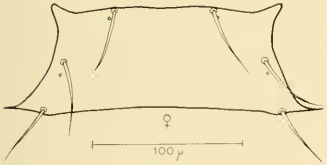

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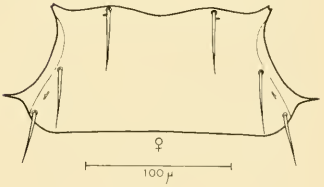

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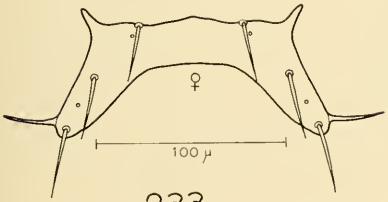

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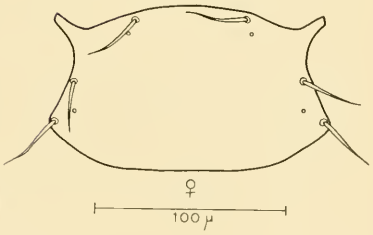
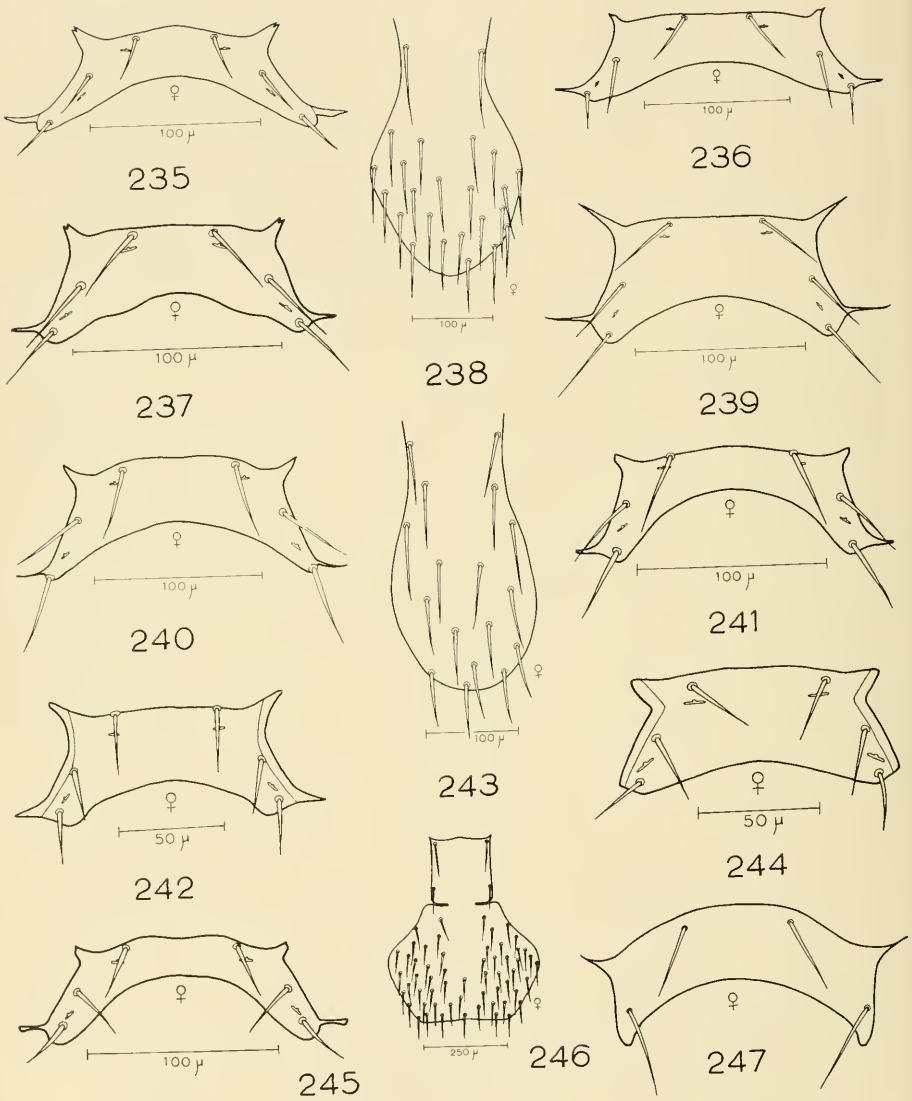
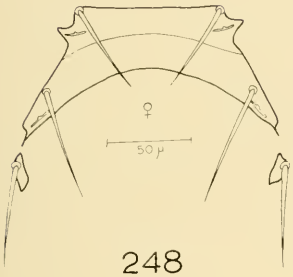


234

Figs. 225-234. Sternal plates: 225, *Hirstionyssus invaginatus;* 227, *H. invaginatus* variant; 228, *H. eutamiae;* 229, *H. utahensis;* 230, *H. thomomys;* 232, *H. femuralis;* 233, *H. angustus;* 234, *H. longichelae.* Genitoventral plates: 226, *Haemogamasus alaskensis;* 231, *Brevisterna montanus.*



Figs. 235-247. Sternal plates: 235, *Hirstionyssus torus;* 236, *H. neotomae;* 237, *H. neotomae* variant A; 239, *H. bisetosus;* 240, *H. isabellinus;* 241, *H. triacanthus;* 242, *H. hilli;* 244, *H. hilli* variant; 245, *H. incomptus;* 247, *Dermanyssus gallinae.* Genitoventral plates: 238, *Ischyropoda armatus;* 243, *Haemogamasus pontiger;* 246, *Eulaelaps stabularis.*



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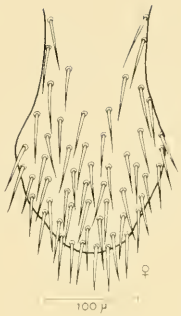

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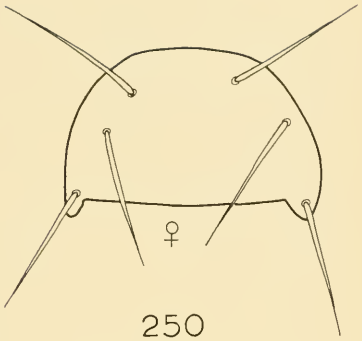

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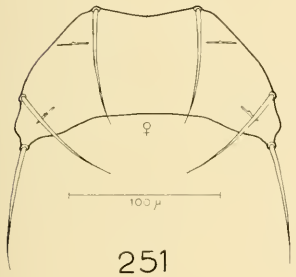

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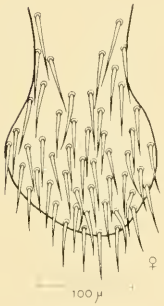

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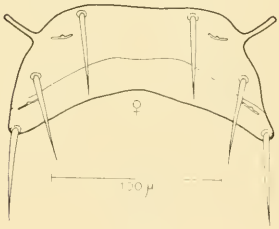

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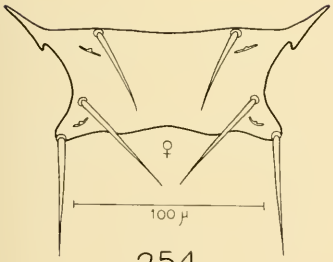

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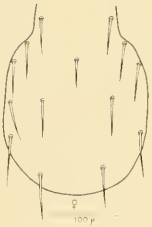

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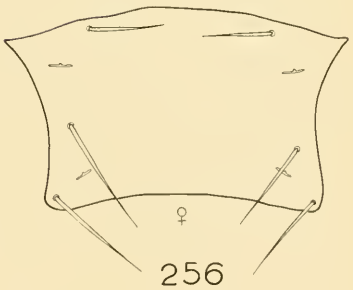

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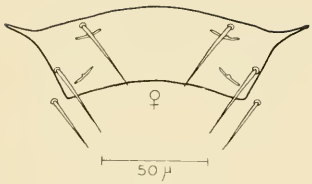
Figs. 248-256. Sternal plates: 248. *Ichoronyssus robustipes;* 250, *Dermanyssus sanguineus;* 251, *D. hecki;* 253, *Steatonyssus antrozoi;* 254, *Ornithonyssus bacoti;* 256. *O. aridus.* Genitoventral plates: 249. *Haemogamasus ambulans* form A; 252, *H. ambulans* form B; 255. *Myonyssus montanus.*



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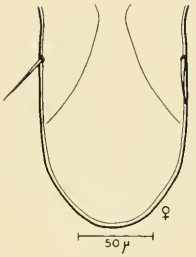

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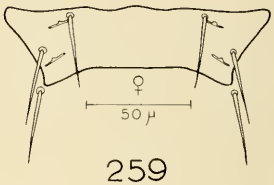

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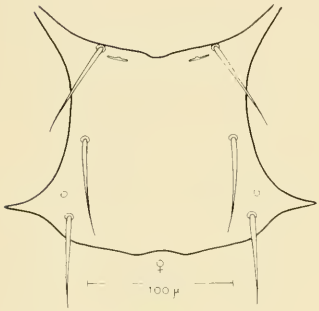

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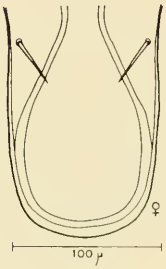

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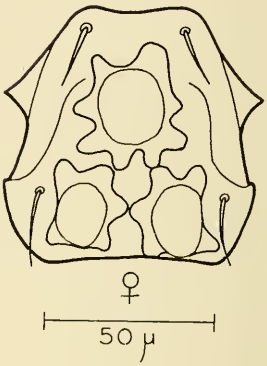

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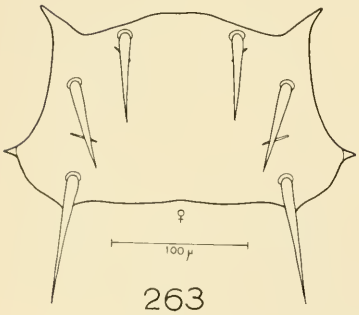

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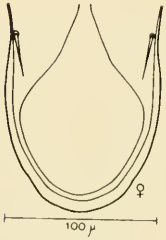

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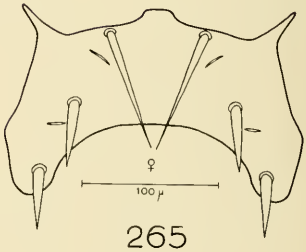

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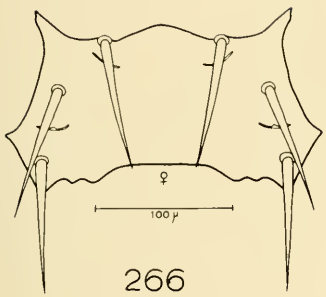
Figs. 257-265. Sternal plates: 257, *Ornithonyssus sylviarum;* 259, *O. sylviarum* variant; 260, *Androlaelaps leviculus;* 262, *Kleemania* sp.; 263, *Laelaps multispinosus;* 265, *L. kochi.* Genitoventral plates: 258. *Hirstionyssus punctatus;* 261, *H. palustris;* 264, *H. utahensis.*



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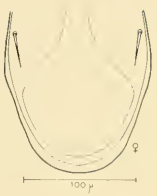

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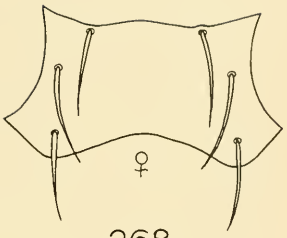

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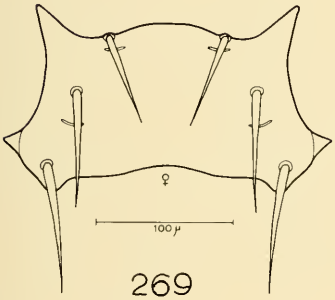

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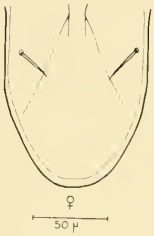

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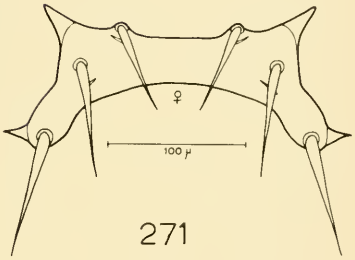

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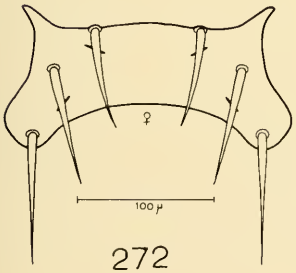

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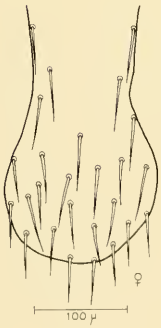

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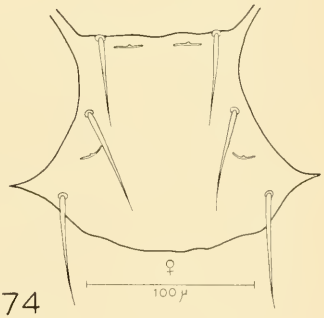

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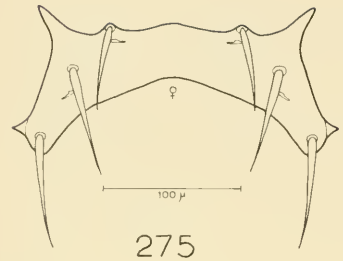
Figs. 266-274. Sternal plates: 266, *Laelaps incilis;* 268, *L. nuttallii;* 269, *Eubrachylaelaps crowei;* 271, *E. hollisteri;* 272, *E. circularis;* 274, *Hypoaspis lubrica.* Genitoventral plates: 267, *Hirstionyssus invaginatus* variant; 270, *H. tarsalis;* 273, *Haemogamasus ambulans* form C.



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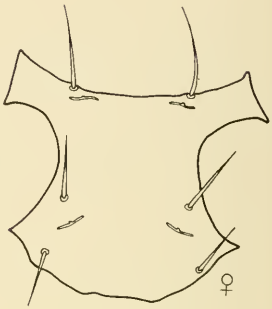

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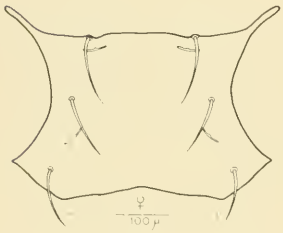

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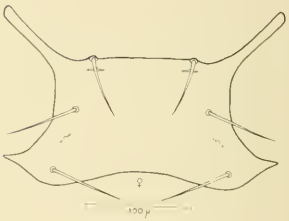

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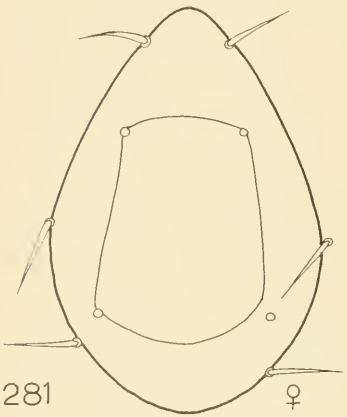

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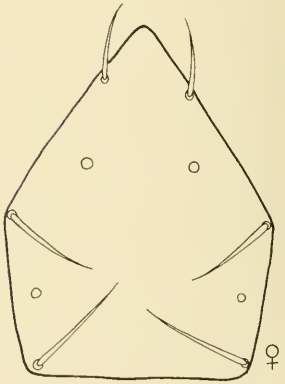

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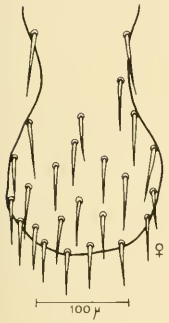
Figs. 275-283. Sternal plates: 275, *Eubrachylaelaps debilis;* 277, *Hypoaspis gurabensis;* 278, *Haemolaelaps casalis;* 280, *H. glasgowi;* 281, *Paraspinturnix globosus;* 283. *Spinturnix orri.* Genitoventral plates: 276, *Hirstionyssus invaginatus;* 279, *H. cutamiae;* 282, *H. staffordi.*



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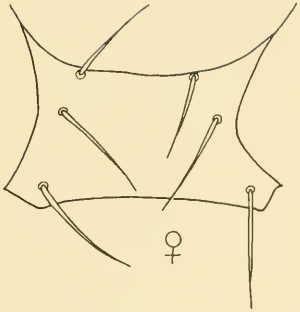

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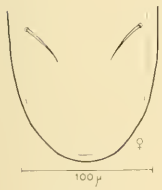

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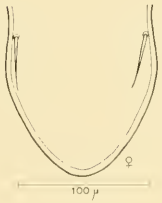

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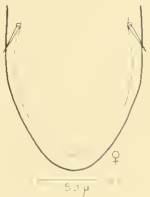

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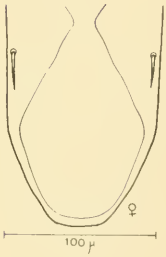

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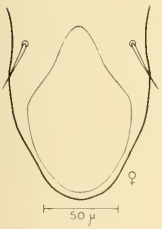

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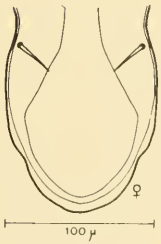

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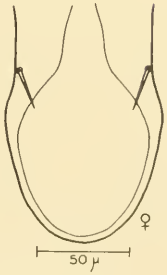

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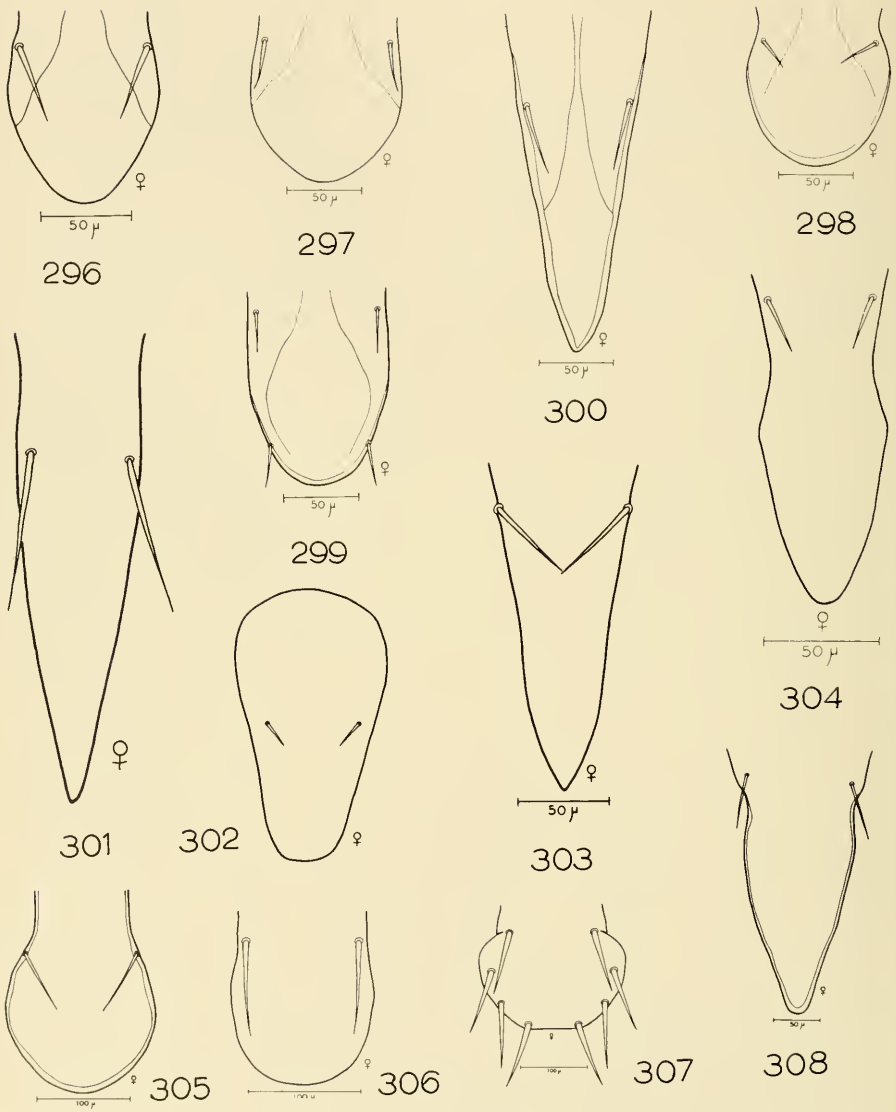
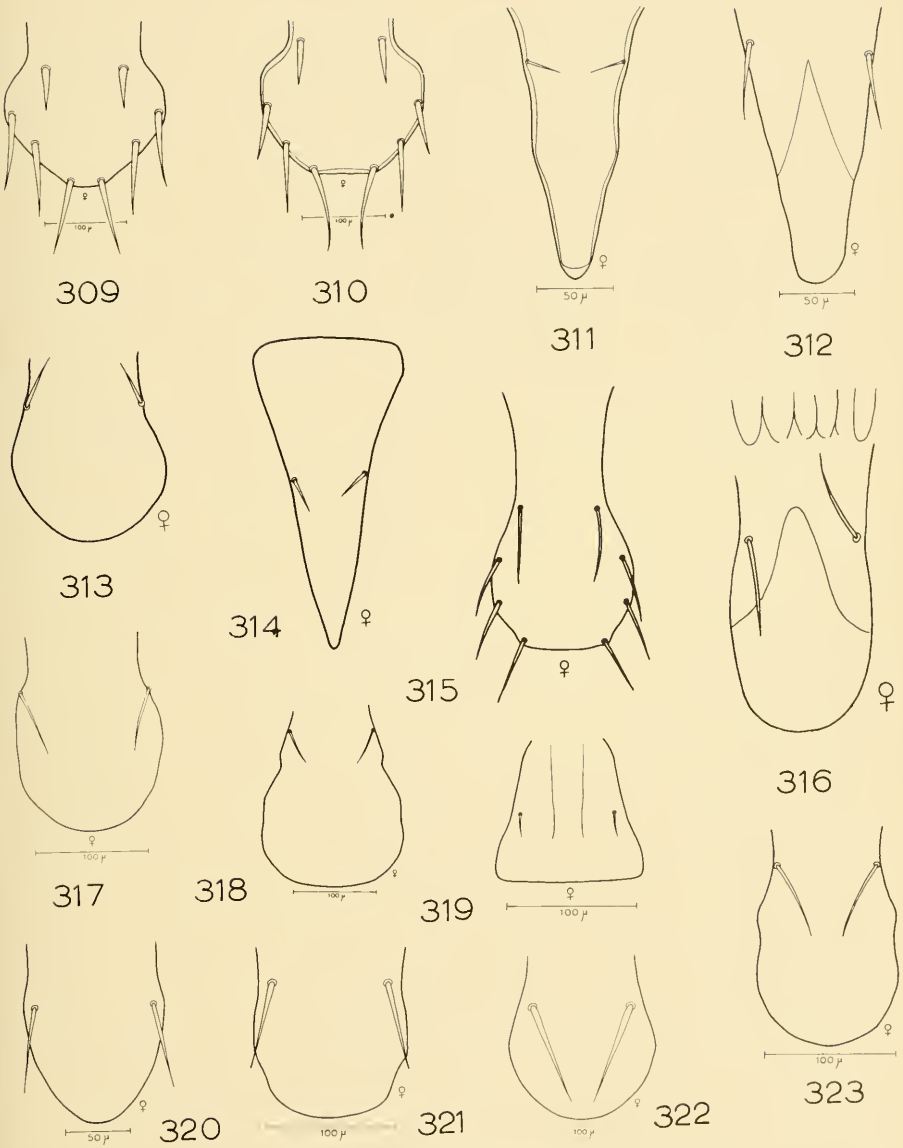
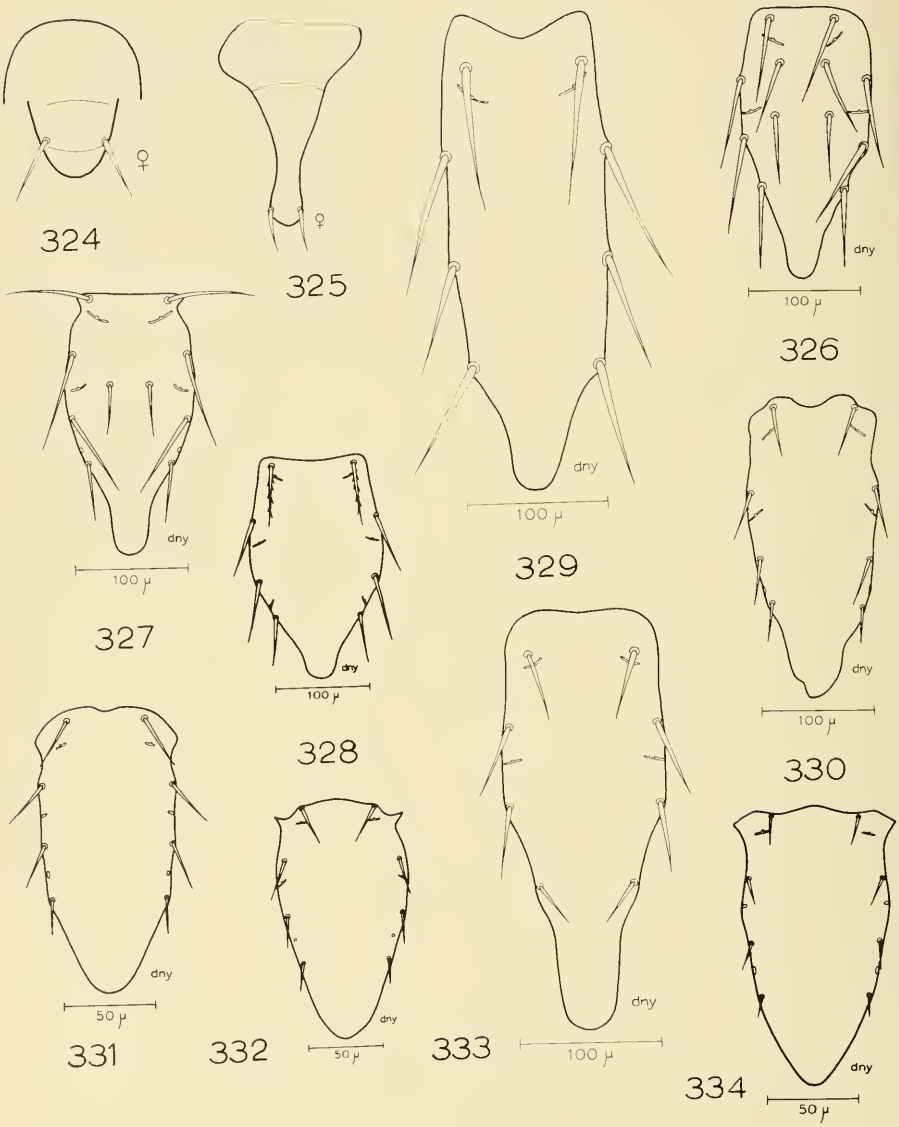
Figs. 284-295. Genitoventral plates: 284. *Haemogamasus ambulans* form D; 286, *Hirstionyssus affinis*; 287. *Haemogamasus longitarsus*; 288, *Hirstionyssus femuralis*; 289, *H. thomomys*; 290, *H. longichelae*; 291, *H. torus*; 292, *H. neotomae*; 293, *H. incomptus*; 294, *H. angustus*; 295, *H. isabellinus*. 285, sternal plate of *Haemolaelaps geomys*.



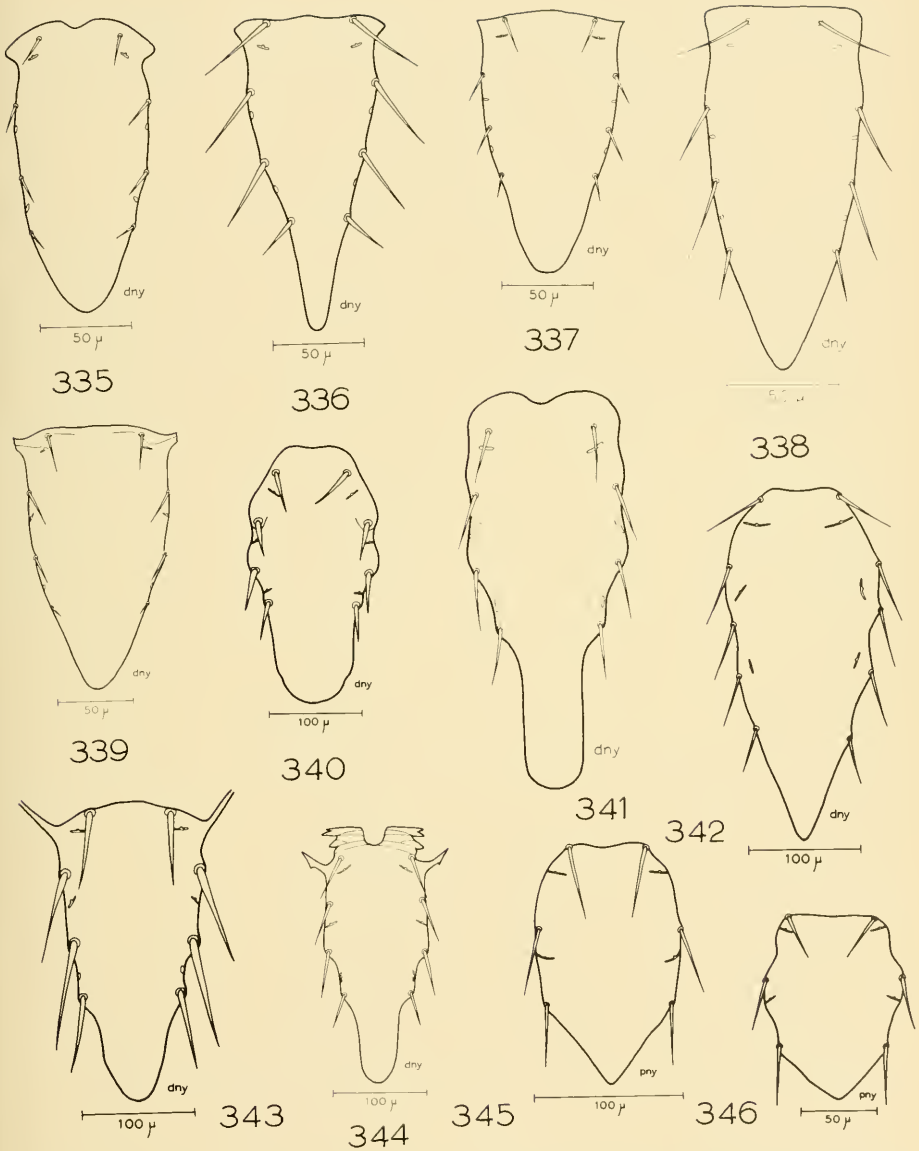
Figs. 296-308. Genitoventral plates. 296, *Hirstionyssus triacanthus;* 297, *H. hilli;* 298, *H. hilli* variant; 299, *H. bisetosus;* 300, *Ichoronyssus robustipes;* 301, *Dermanyssus sanguineus;* 302, *D. gallinae;* 303, *Ornithonyssus bacoti;* 304, *O. sylviarum;* 305, *Androlaelaps leviculus;* 306, *Eubrachylaelaps crowei;* 307, *Laelaps incilis;* 308, *D. becki.*



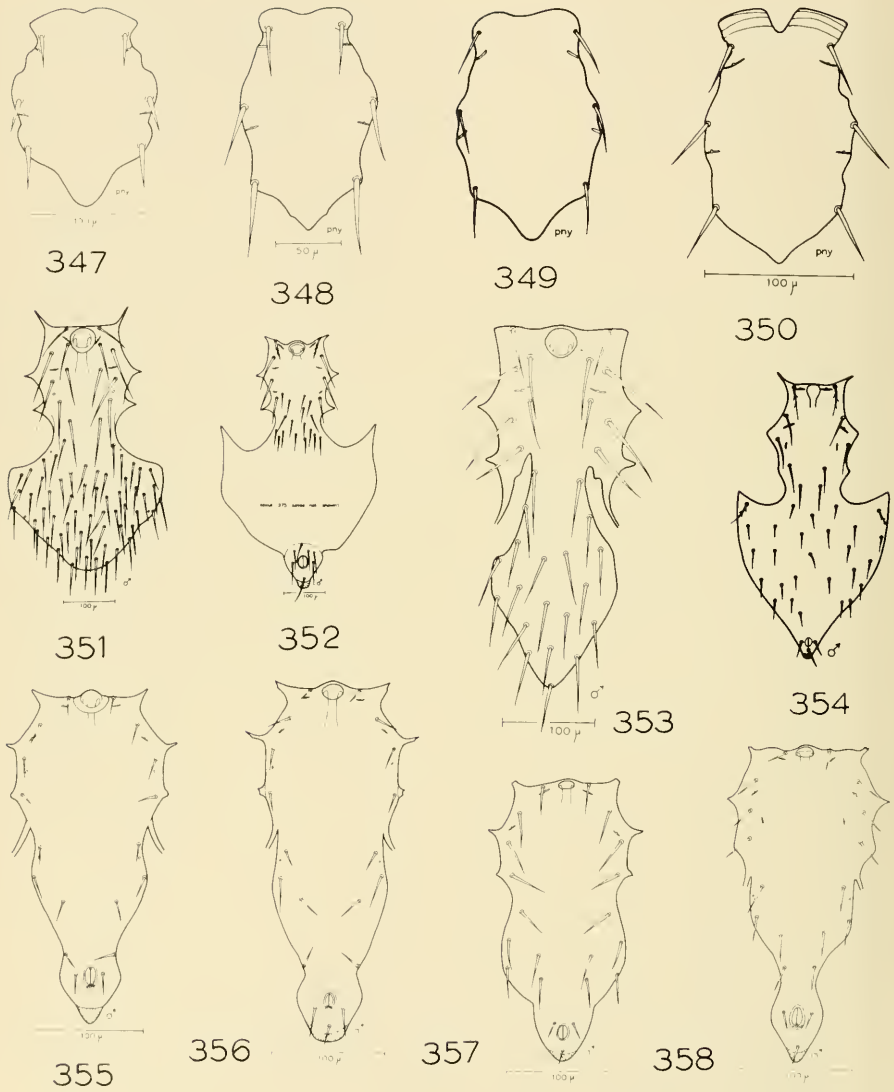
Figs. 309-323. Genitoventral plates. 309, *Laelaps kochi*; 310, *L. multispinosus*; 311, *Ornithonyssus sylviarum*; 312, *Steatonyssus antrozoi*; 313, *Hypoaspis gurabensis*; 314, *O. aridus*; 315, *L. nuttalli*; 316, *Haemolaelaps geomys*; 317, *Hypoaspis lubrica*; 318, *Haemolaelaps casalis*; 319, *Kleemania* sp.; 320, *Eubrachylaelaps hollisteri*; 321, *E. debilis*; 322, *E. circularis*; 323, *Haemolaelaps glasgowi*.



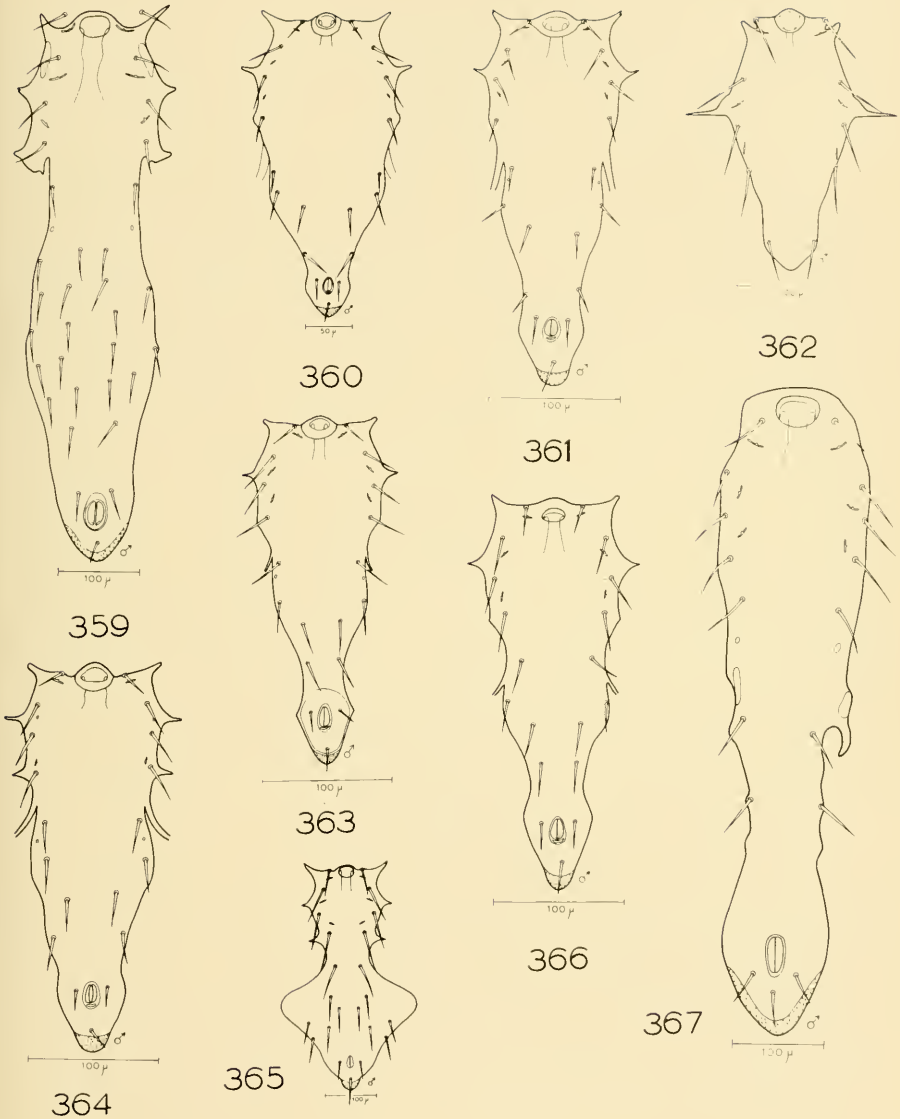
Figs. 324-334. Genitoventral plates: 324, *Spinturnix orri;* 325, *Paraspinturnix globosus.* Sternogenital plates: 326, *Ischyropoda armatus;* 327, *I. furmani;* 328, *Haemogamasus ambulans* form B; 329, *H. alaskensis;* 330, *Brevisterna utahensis;* 331, *Hirstionyssus neotomae;* 332, *H. femuralis;* 333, *Haemolaelaps casalis;* 334, *Hirstionyssus utahensis.*



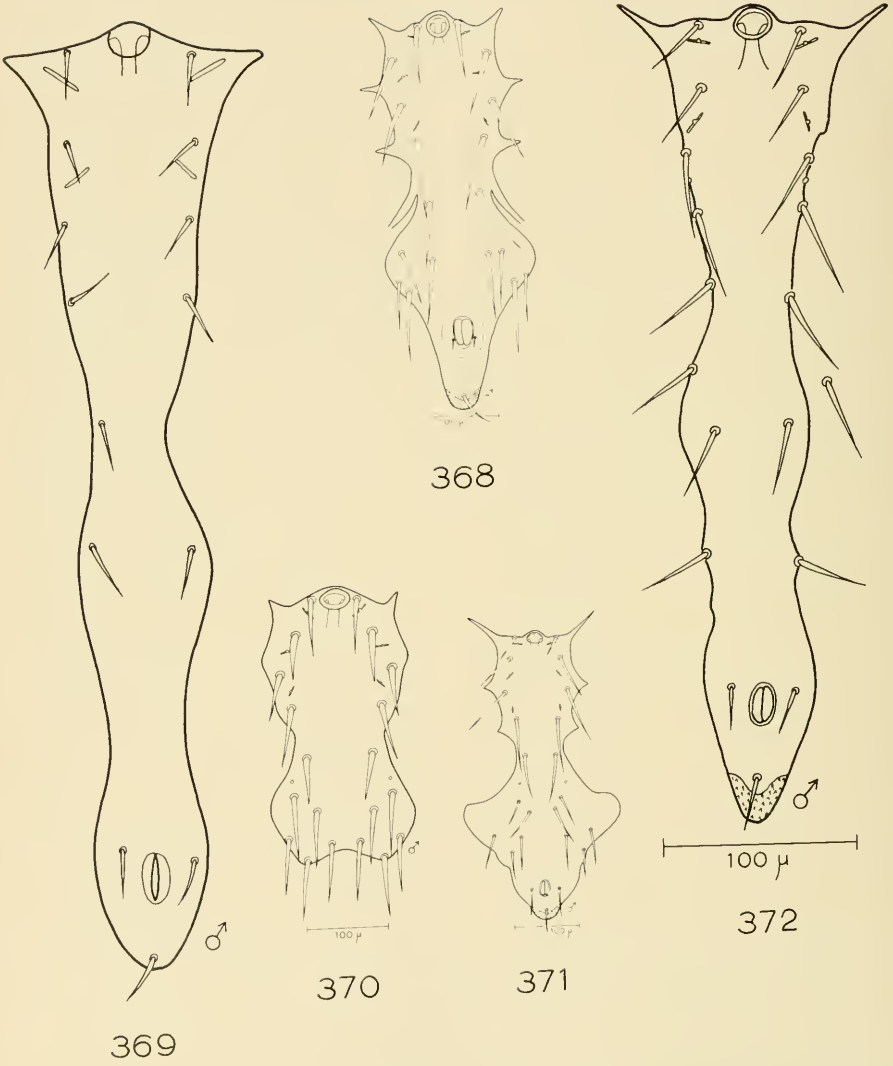
Figs. 335-346. Sternogenital plates. 335, *Hirstionyssus torus;* 336, *H. thomomys;* 337, *H. incomptus;* 338, *H. bisetosus;* 339, *H. isabellinus;* 340, *Laelaps kochi;* 341, *Eubrachylaelaps circularis;* 342, *Dermanyssus hecki;* 343, *L. multispinosus:* 344, *Haemolaelaps glasgowi;* 345, *D. hecki;* 346, *Ornithonyssus bacoti.*



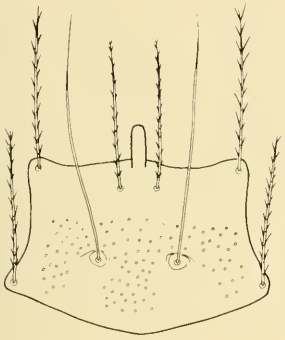
Figs. 347-358. Sternogenital plates: 347, *Laelaps kochi;* 348, *L. multispinosus;* 349, *Eubrachylaelaps circularis;* 350, *Haemolaelaps glasgowi.* Sterno-genitoventral plates: 351, *Ischyropoda armatus;* 353, *I. furmani.* Holoventral plates: 352, *Haemogamasus ambulans* form B; 354, *H. pontiger;* 355, *Hirstionyssus utahensis;* 356, *H. torus;* 357, *H. femuralis;* 358, *H. neotomae* variant B.



Figs. 359-367. Holoventral plates: 359, *Brevisterna utahensis;* 360, *Hirstionyssus thomomys;* 361, *H. neotomae* variant C; 363, *H. neotomae* variant A; 364, *H. incomptus;* 365, *Eubrachylaelaps circularis;* 366, *H. bisetosus;* 367, *Dermanyssus becki.* 362, sternogenital plate of *Ichoronyssus robustipes.*



Figs. 368-372. Holoventral plates: 368, *Laelaps multispinosus;* 369, *Ornithonyssus aridus;* 371, *Haemolaelaps glasgowi;* 372, *O. bacoti.* 370, sterno-genitoventral plate of *L. kochi.*



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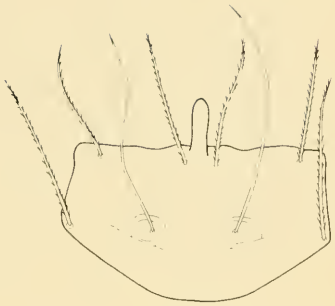

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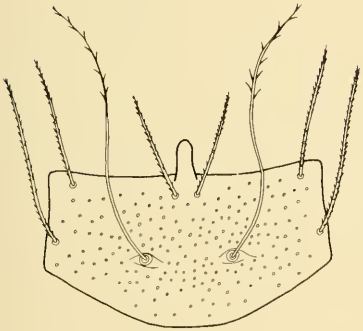

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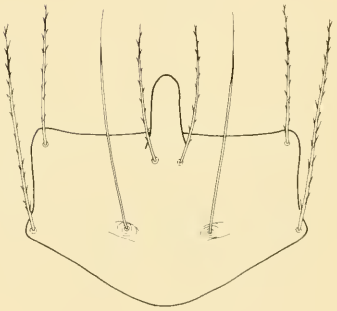

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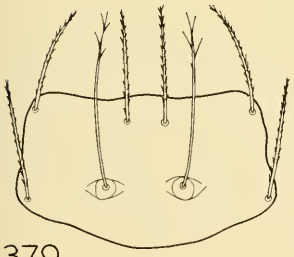

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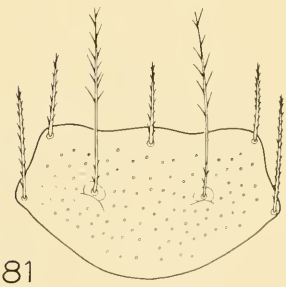

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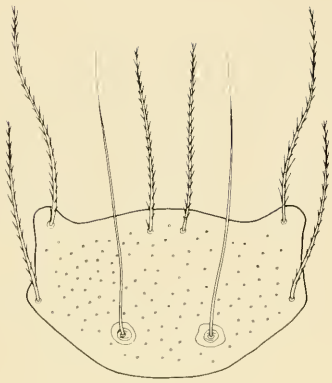
Figs. 373-381. Scuta: 373, *Leeuwenhockia americana;* 375. *Odontacarus micheneri,* 376, *O. linsdalei;* 378, *O. hirsutus;* 379, *Whartonia perplexa;* 381. *Trombicula belkini.* Chelicerae: 374, *Ischyropoda armatus;* 377, *Haemogamasus liponyssoides;* 380, *H. ambulans* form B.



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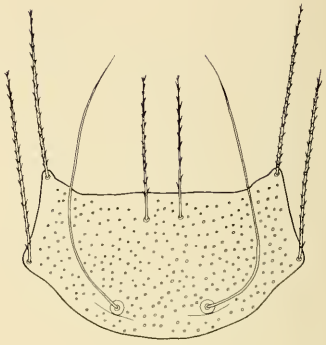

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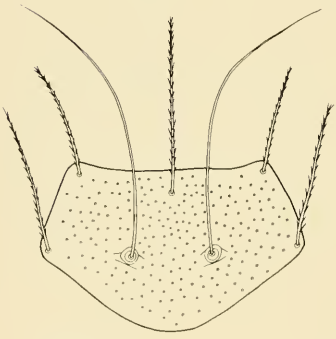

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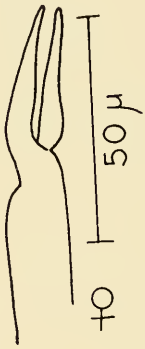

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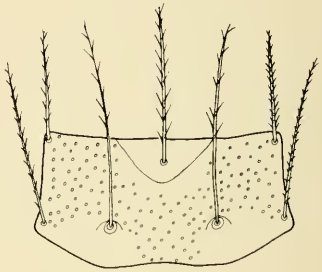

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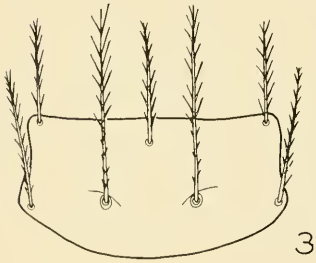

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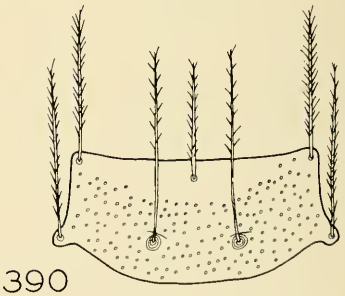
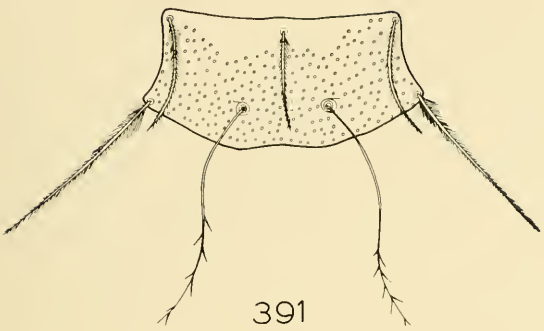


390

Figs. 382-390. Scuta: 382. *Chatia ochotona;* 384, *C. setosa;* 385, *Trombicula californica;* 387, *T. myotis;* 388, *T. hoplai;* 390. *T. panamensis.* Chelicerae: 383. *Haemogamasus ambulans* form A; 386, *Ornithonyssus sylviarum* variant; 389, *Dermanyssus hecki.*



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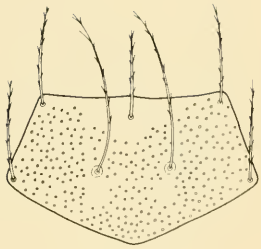

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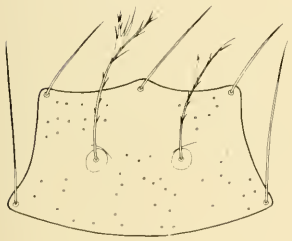

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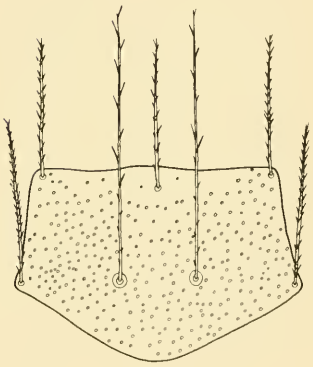

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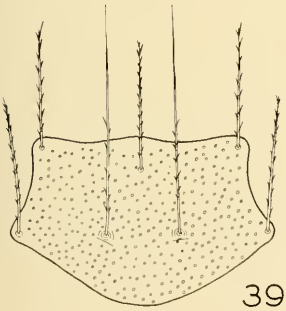

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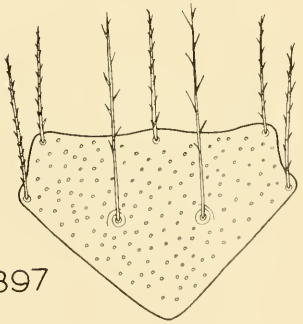
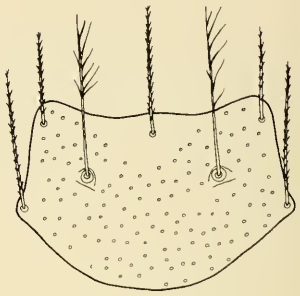


397

Figs. 391-397. Scuta: 391, *Trombicula potosina;* 392, *T. subsignata;* 393, *T. univari;* 394, *T. harperi;* 395. *T. jewetti;* 397, *T. esoensis.* 396, chelicera of *Haemogamasus ambulans* form D.

398



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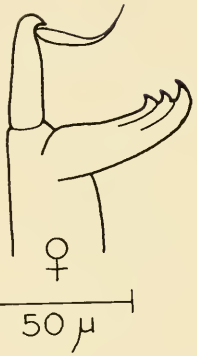

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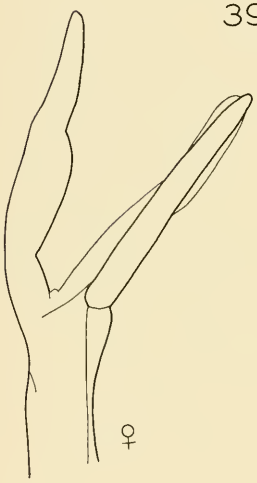

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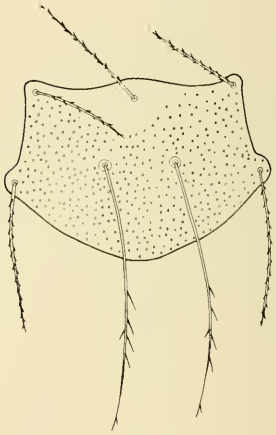

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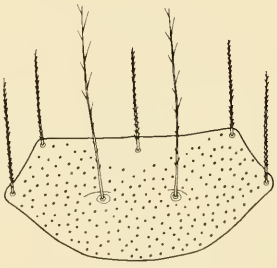

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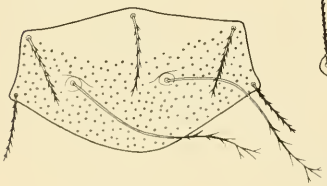

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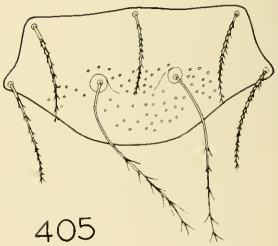
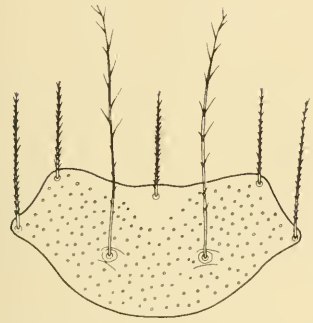


405

Figs. 398-405. Scuta: 398, *Trombicula sargenti;* 399, *T. bakeri;* 402, *T. montanensis;* 403, *T. kardosi;* 404, *T. doremi;* 405, *T. allredi.* Chelicerae: 400, *Haemogamasus ambulans* form C; 401 *Ornithonyssus aridus.*



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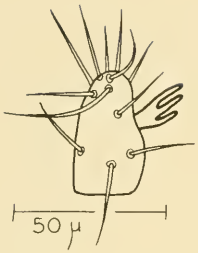

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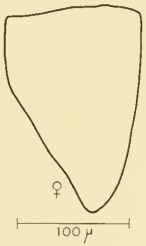

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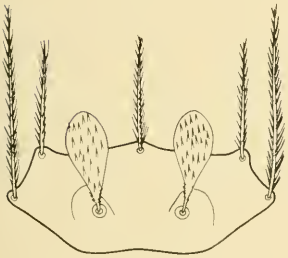

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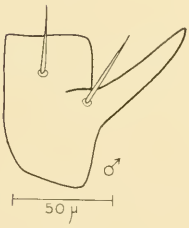

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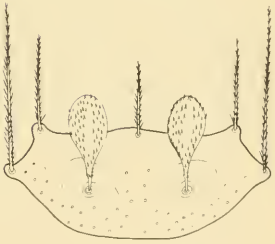

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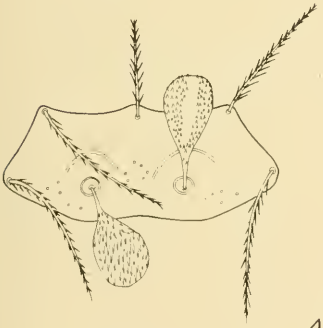

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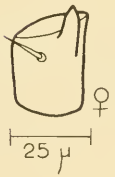

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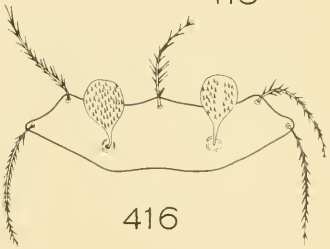
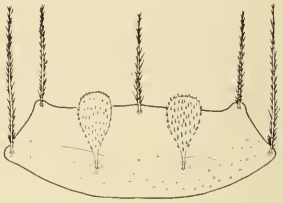
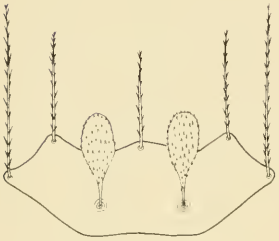
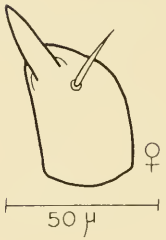


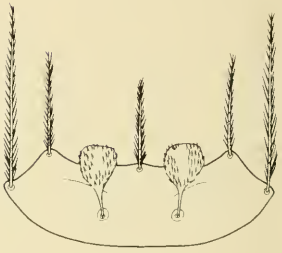
416

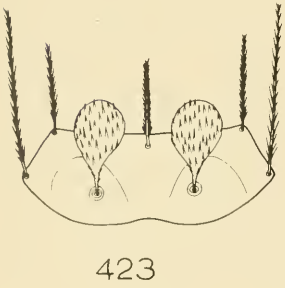
Figs. 406-416. Scuta: 406, *Trombicula arenicola;* 408, *Euschoengastia radfordi;* 409. *E. criceticola;* 411, *E. rotunda;* 413, *E. obesa;* 414. *E. fasolla;* 416. *E. pomerantzi.* 407, *Macrocheles* sp. specialized seta of palpal tarsus; 410, *Eulaelaps stabularis* metapodal plate; 412, *Ichoronyssus robustipes* femur IV; 415. *Ornithonyssus sylviarum* palpal trochanter.

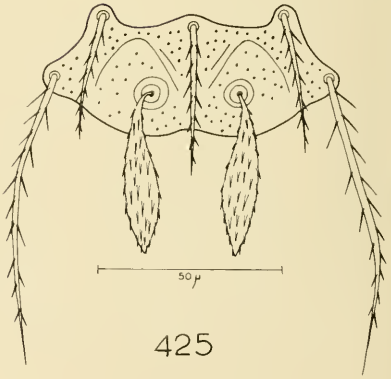




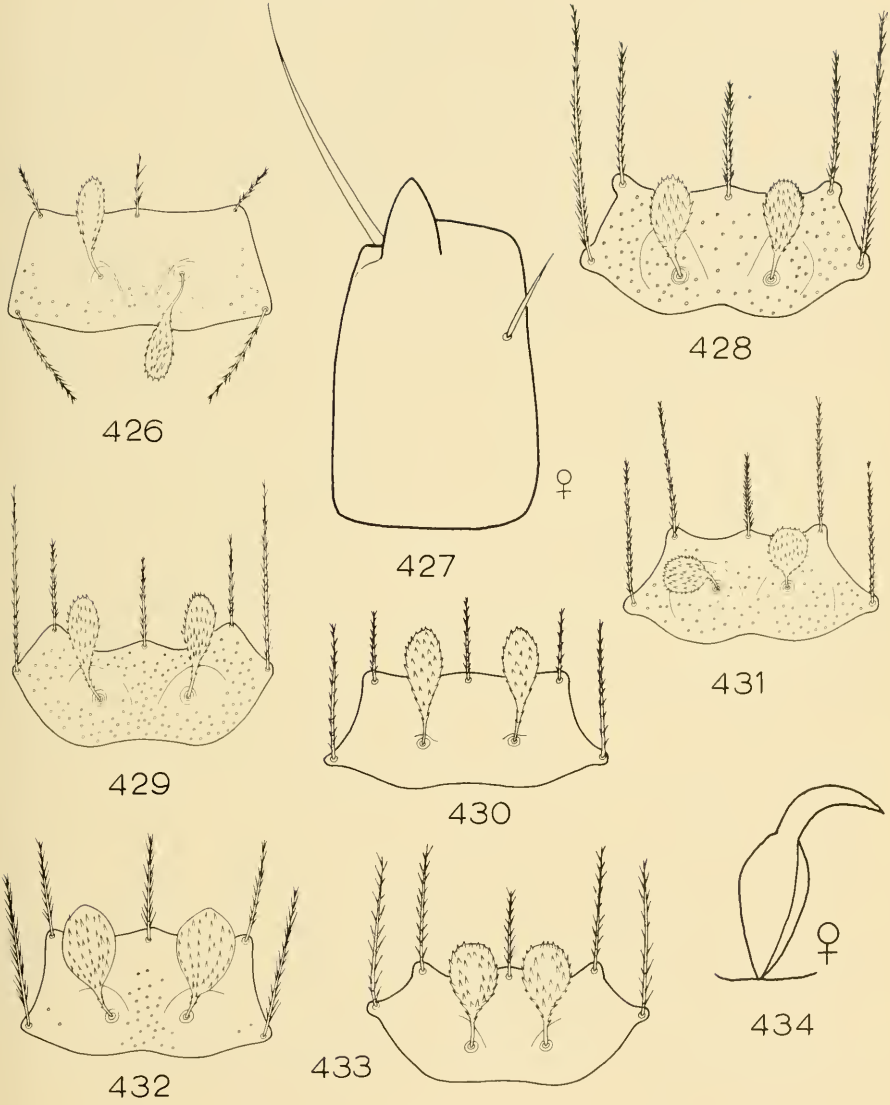




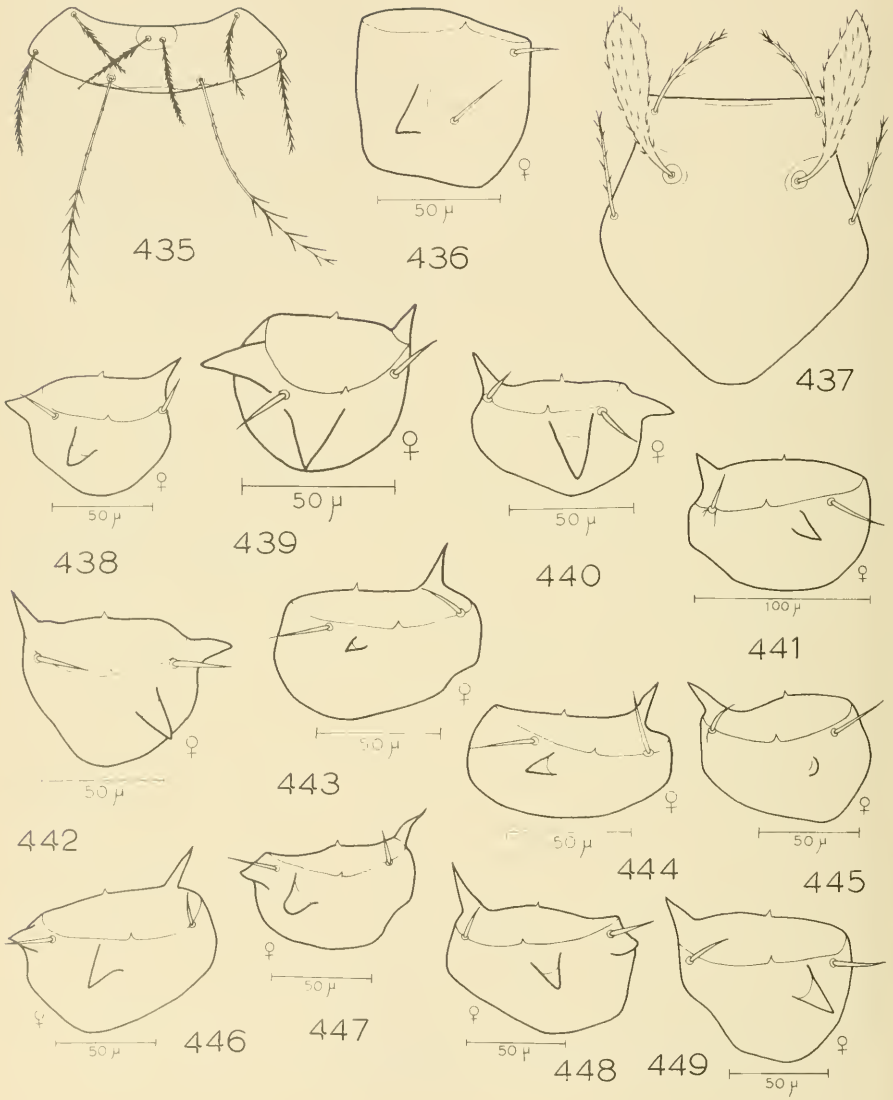




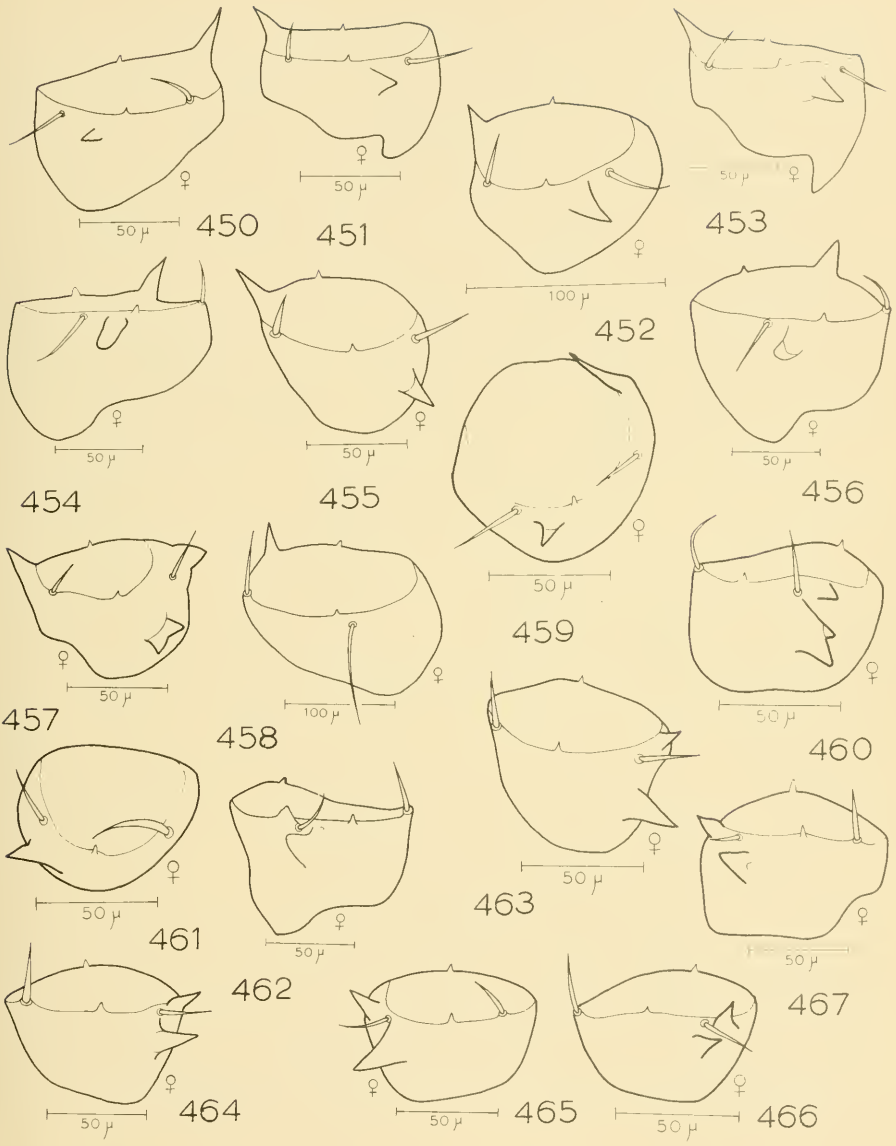
Figs. 417-425. Scuta: 417, *Euschoengastia lanceolata;* 419, *E. lanei;* 420, *E. luteodema;* 422, *E. sciuricola;* 423, *E. cynomyicola;* 425, *E. soricinus.* Palpal trochanters: 418, *Ichoronyssus robustipes;* 421, *Steatonyssus antrozoi.* 424. *Hypoaspis gurabensis* body seta.



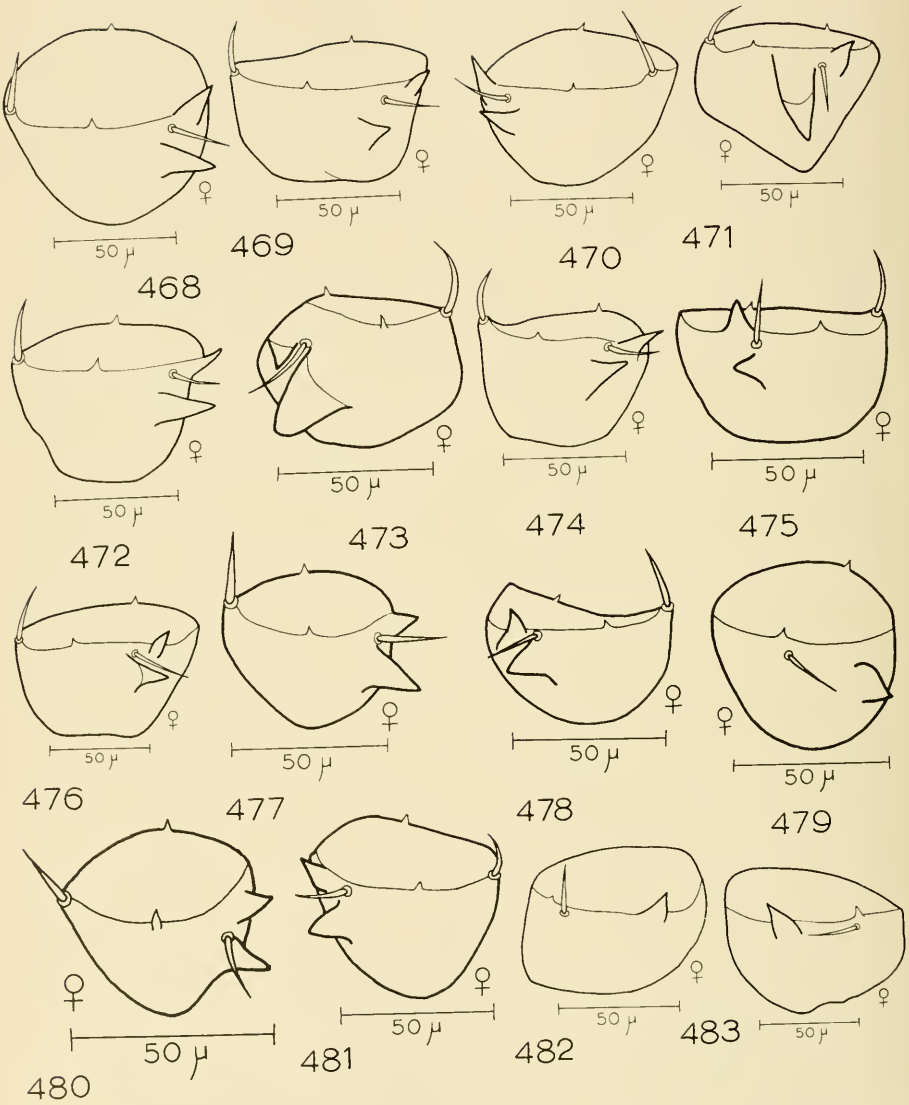
Figs. 426-434. Scuta: 426, *Euschoengastia utahensis;* 428, *E. oregonensis;* 429, *E. cordiremus;* 430, *E. lacerta;* 431, *E. decipiens;* 432, *E. furmani;* 433, *E. hoffmannae.* 427, *Ornithonyssus aridus* palpal trochanter; 434, *Haemolaelaps glasgowi* specialized seta on cheliceral digit.



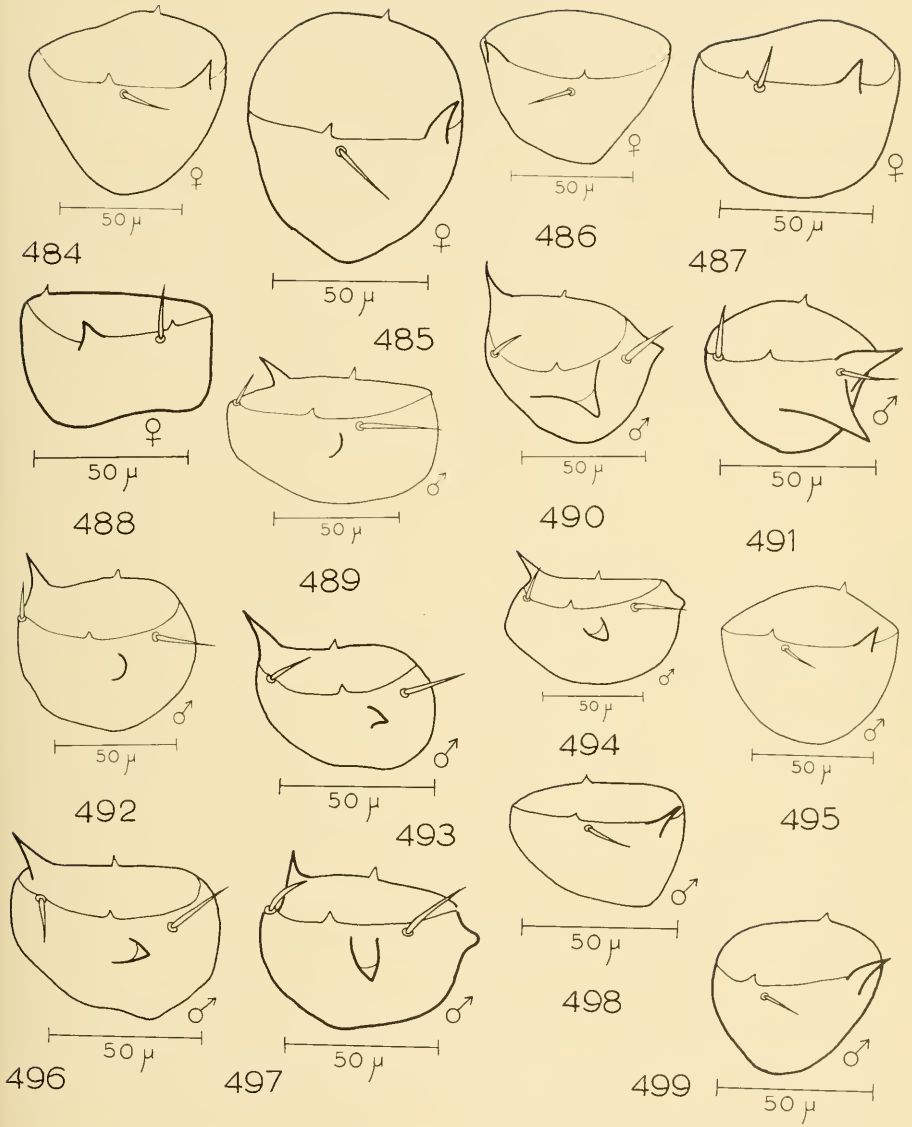
Figs. 435-449. Coxae II of *Hirstionyssus*: 438, *incomptus;* 439, *hilli* variant; 440, *hilli;* 441, *isabellinus;* 442, *triacanthus;* 443, *bisetosus;* 444, *neotomae;* 445, *torus;* 446, *thomomys;* 447, *longichelae;* 448, *femuralis;* 449, *angustus*. Scuta: 435, *Bernia marita;* 437, *Gahrlepia americana*. 436, *H. staffordi* coxa I.



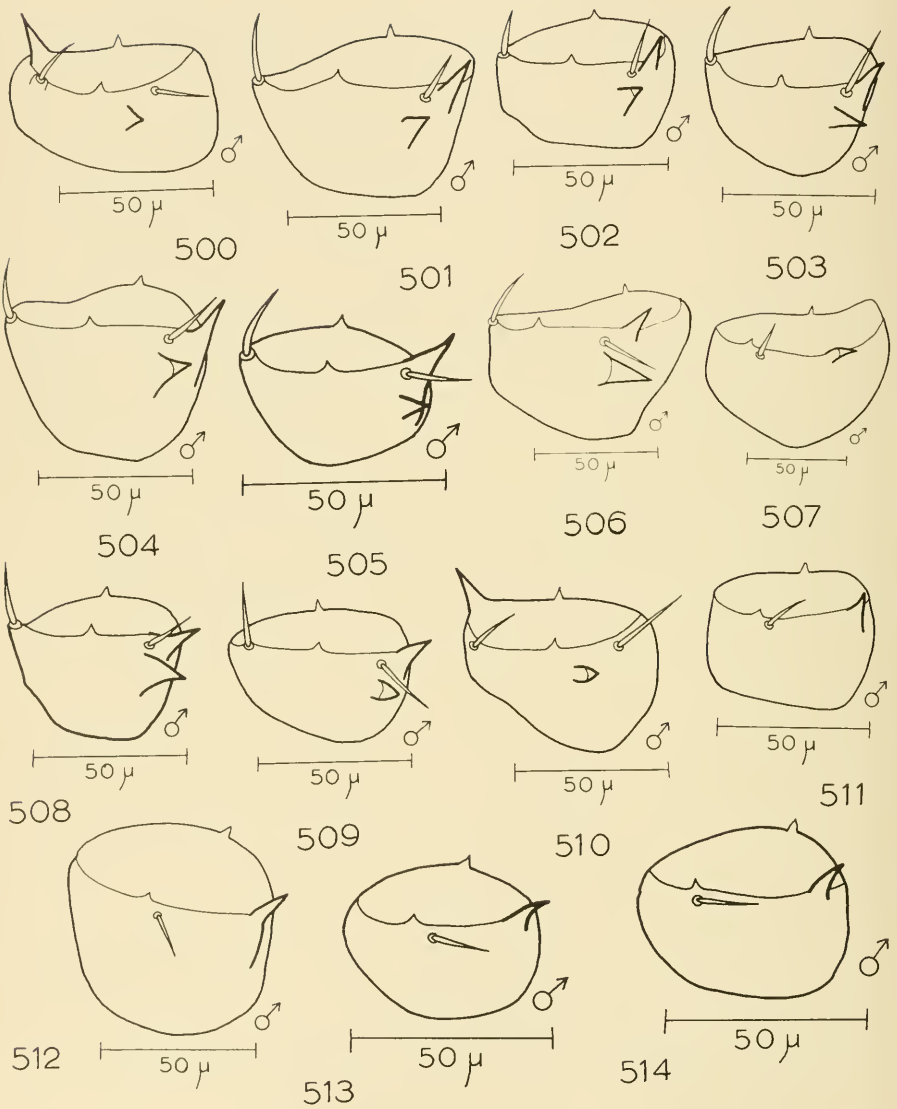
Figs. 450-467. Coxae II of *Hirstionyssus*: 450, *utahensis;* 451, *eutamiae;* 452, *invaginatus* variant; 453, *invaginatus;* 454, *punctatus;* 455, *palustris;* 456, *affinis;* 457, *staffordi;* 459, *tarsalis.* 458, *Ischyropoda armatus* coxa II. Coxae III of *Hirstionyssus:* 460, *staffordi;* 461, *tarsalis;* 462, *affinis;* 463, *palustris;* 464, *invaginatus;* 465, *thomomys;* 466, *bisetosus;* 467, *punctatus.*



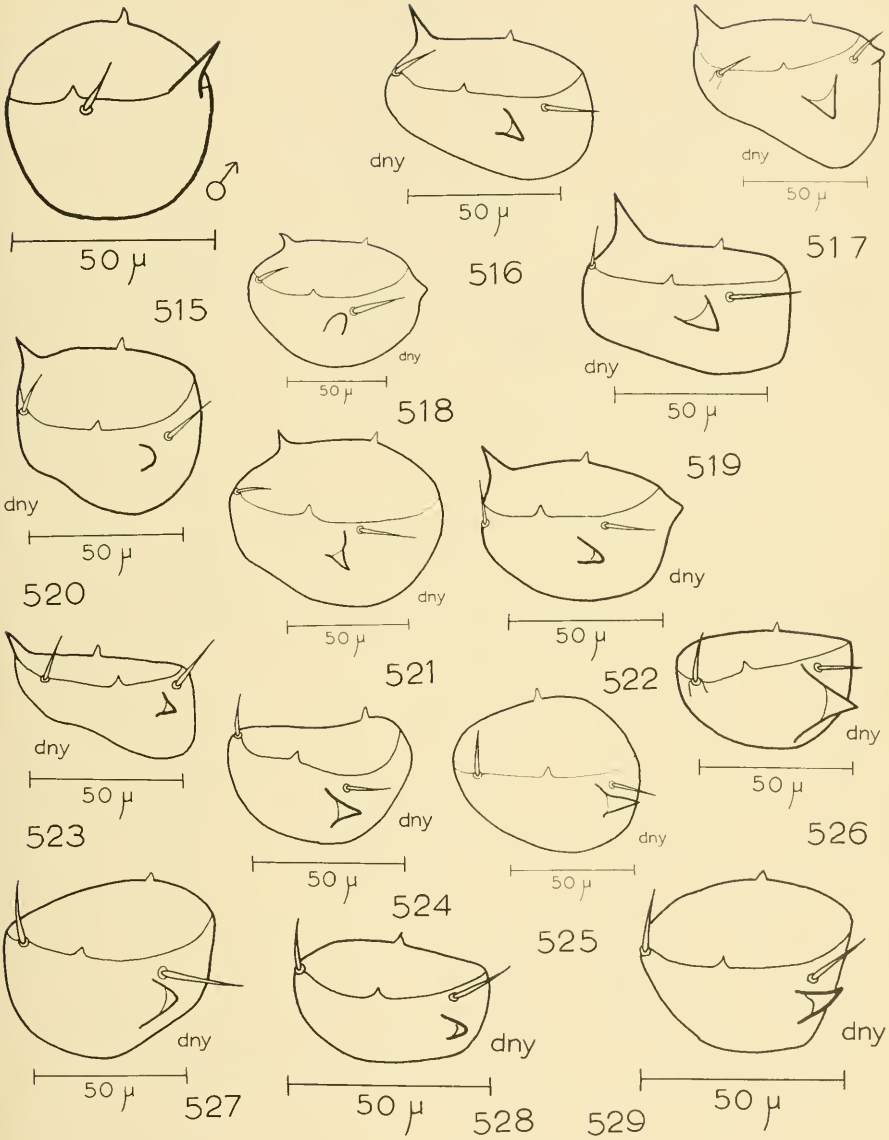
Figs. 468-483. *Hirstionyssus.* Coxae III: 468, *invaginatus* variant; 469, *eutamiae;* 470, *utahensis;* 471, *femuralis;* 472, *angustus;* 473, *longichelae;* 474, *torus;* 475, *neotomae;* 476, *isabellinus;* 477, *triacanthus;* 478, *hilli;* 480, *hilli* variant; 481, *incomptus.* Coxae IV: 479, *staffordi;* 482, *eutamiae;* 483, *punctatus.*



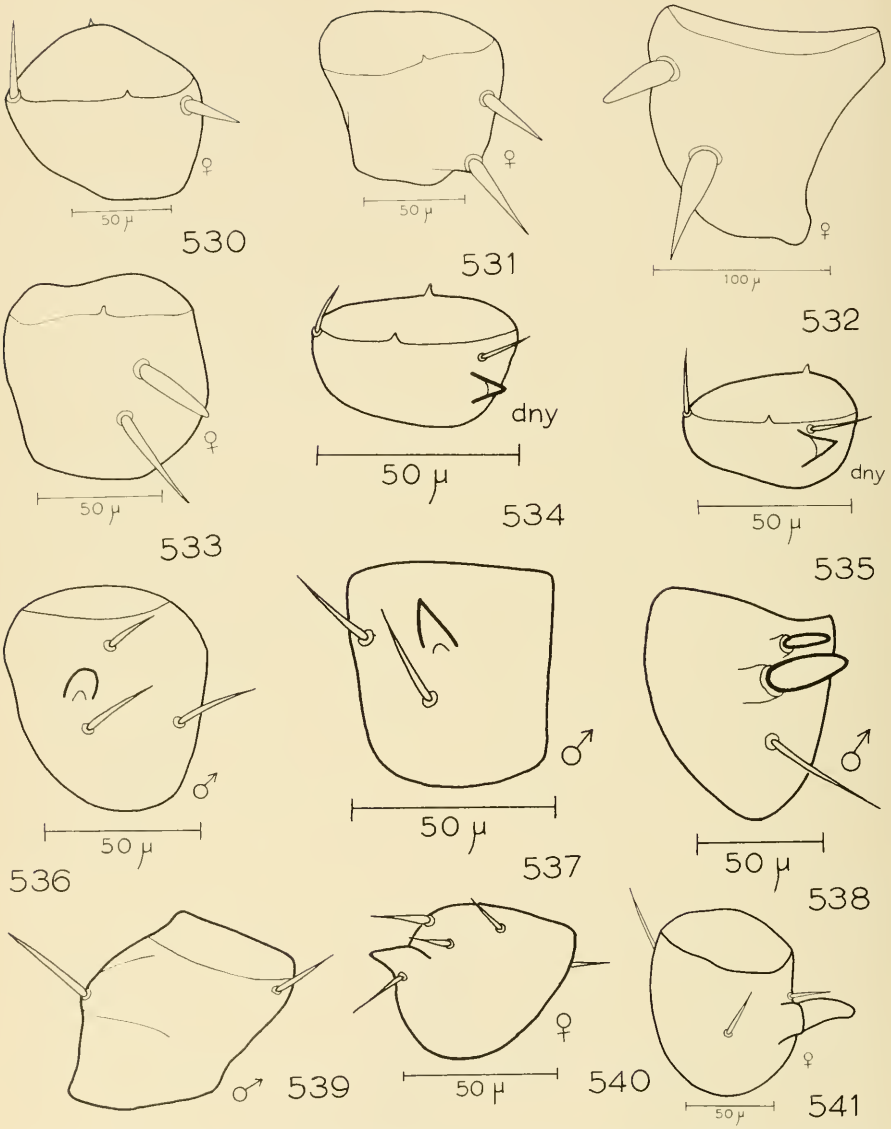
Figs. 484-499. *Hirstionyssus.* Coxae II: 489, *utahensis;* 490, *femuralis;* 492, *torus;* 493, *neotomae* variant A; 494, *thomomys;* 496, *bisetosus;* 497, *incomptus.* Coxa III: 491, *femuralis.* Coxae IV: 484, *invaginatus;* 485, *invaginatus* variant; 486, *utahensis;* 487, *torus;* 488, *neotomae;* 495, *utahensis;* 498, *neotomae* variant B; 499, *femuralis.*



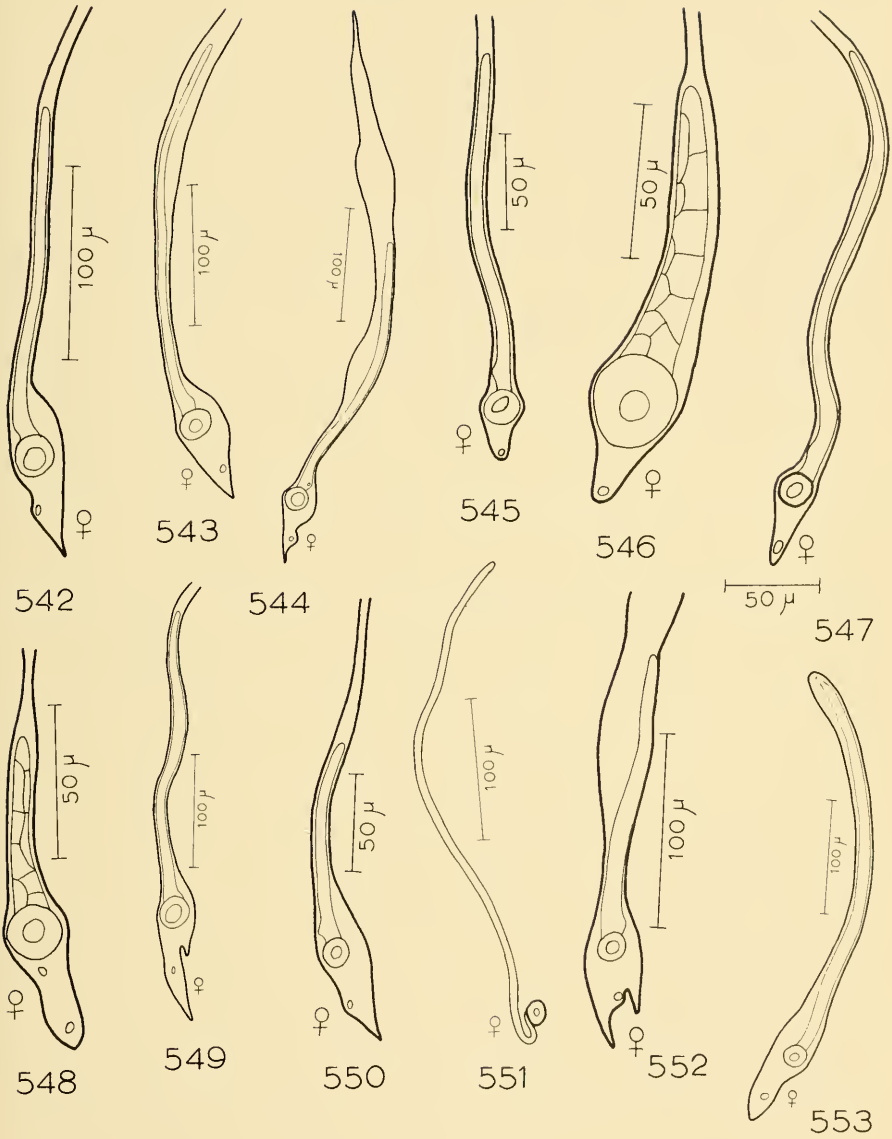
Figs. 500-514. *Hirstionyssus*. Coxae II: 500, *neotomae* variant B; 510, *neotomae* variant C. Coxae III: 501, *utahensis*; 502, *neotomae* variant B; 503, *neotomae* variant C; 504, *torus;* 505, *neotomae* variant A; 506, *thomomys;* 508, *incomptus;* 509, *bisetosus*. Coxae IV: 507, *thomomys;* 511, *bisetosus;* 512, *torus;* 513, *neotomae* variant A; 514, *neotomae* variant C.



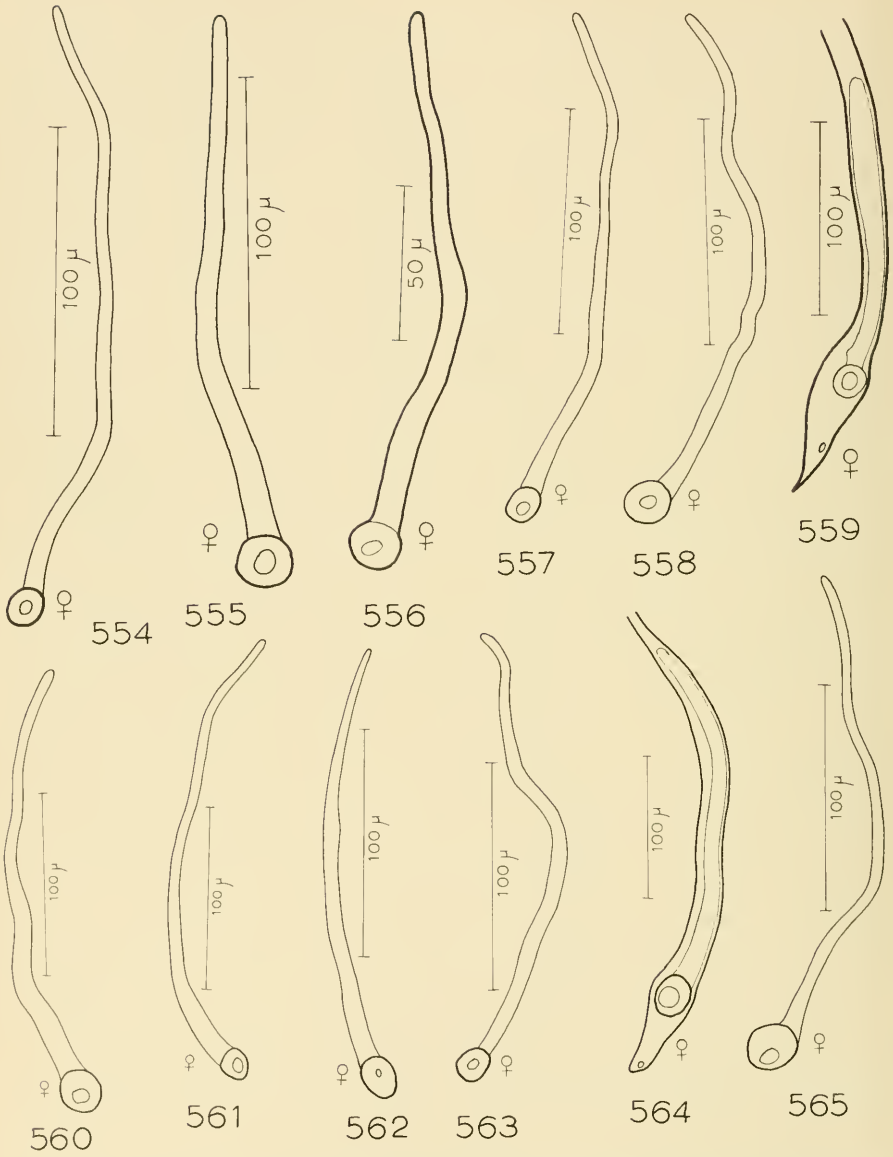
Figs. 515-529. *Hirstionyssus*. Coxae II: 516, *utahensis;* 517, *femuralis;* 518, *thomomys;* 519, *bisetosus;* 520, *torus;* 521, *isabellinus;* 522, *incomptus;* 523, *neotomae*. Coxae III: 524, *utahensis;* 525, *isabellinus;* 526, *femuralis;* 527, *thomomys;* 528, *neotomae;* 529, *torus*. Coxa IV: 515, *incomptus*.



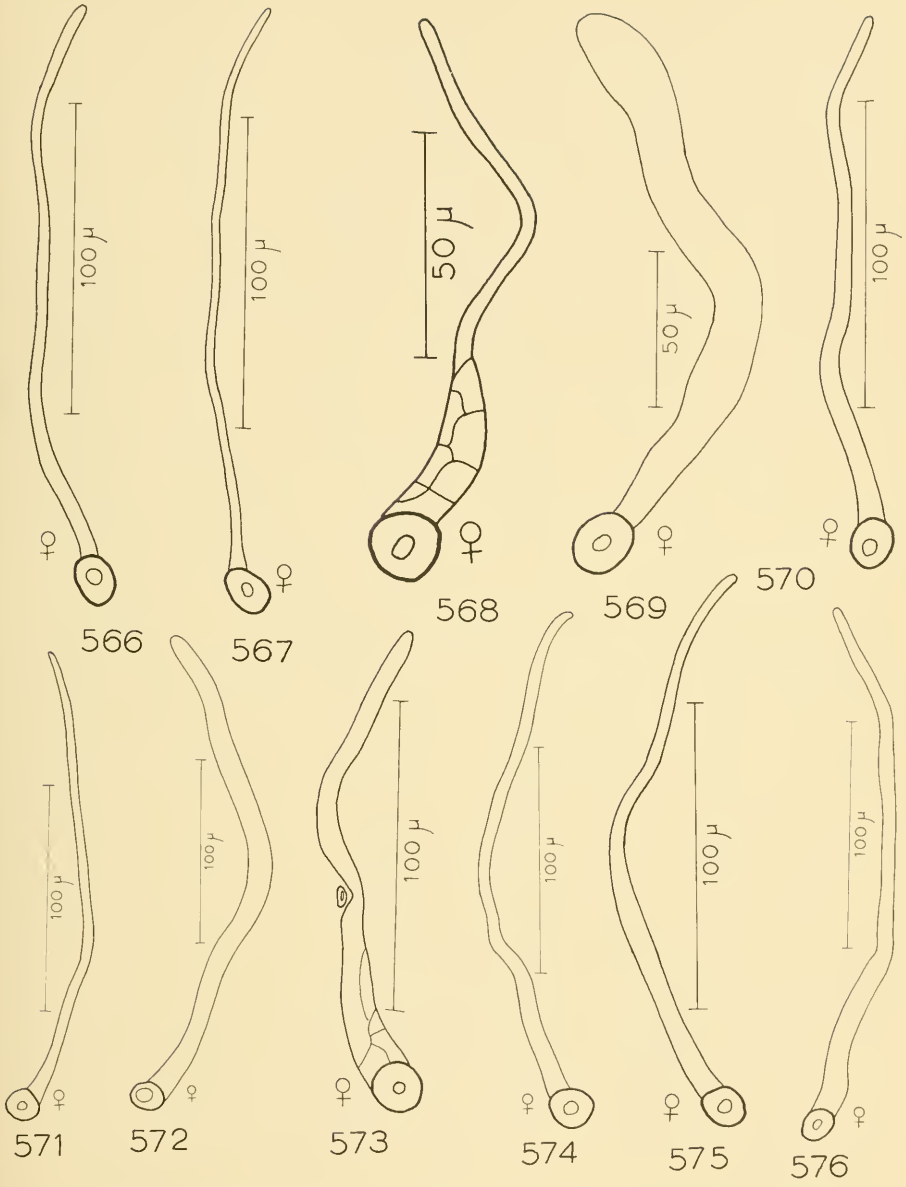
Figs. 530-541. Coxae I: 531, *Laelaps kochi;* 532, *L. multispinosus;* 533, *L. incilis.* Coxae III: 530, *Eubrachylaelaps circularis;* 534, *Hirstionyssus incomptus;* 535, *H. bisetosus.* Femora II: 536, *Ichoronyssus robustipes;* 538, *Ischyropoda armatus;* 540, *H. femuralis;* 541, *Androlaelaps leviculus.* 537, *Ichoronyssus robustipes* femur III. 539, *Ornithonyssus aridus* palpal femur.



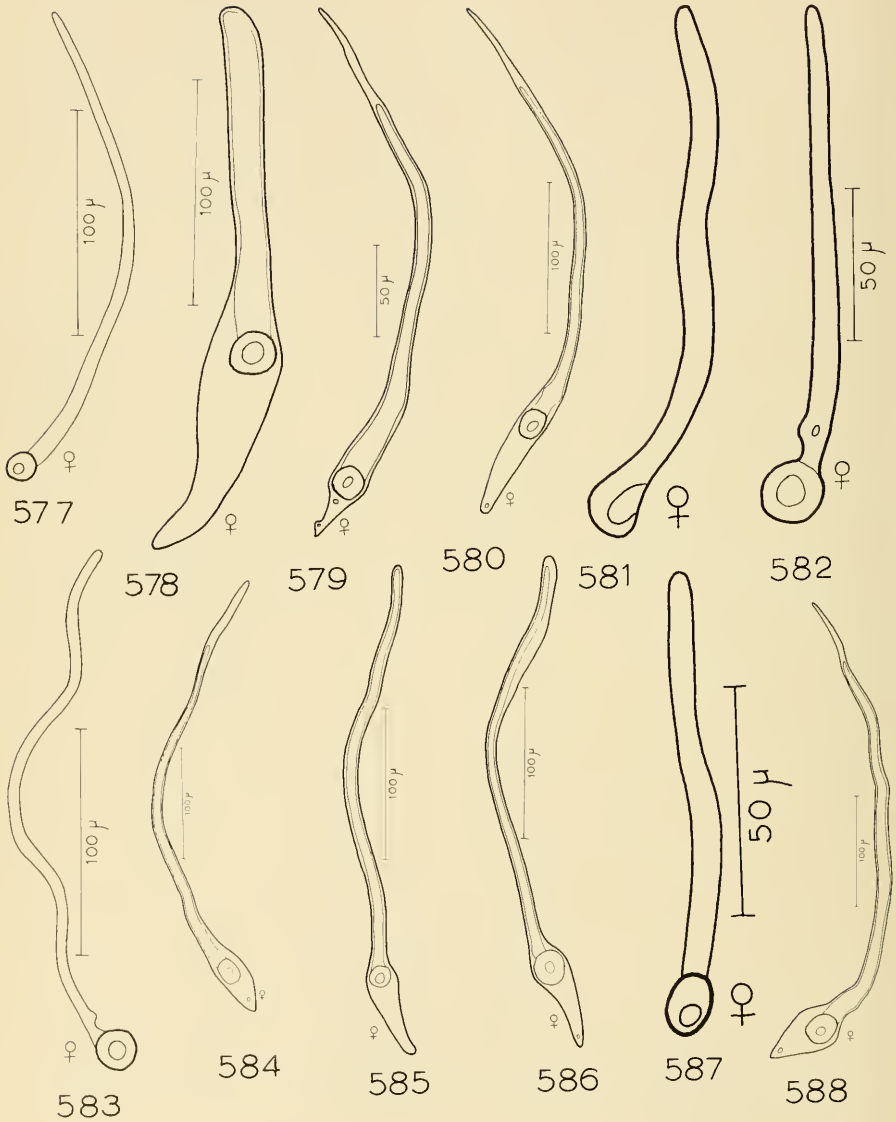
Figs. 542-553. Peritremes. 542, *Haemogamasus ambulans* form C; 543, *H. alaskensis;* 544, *H. ambulans* form A; 545, *Ischyropoda furmani;* 546, *Brevisterna montanus;* 547, *I. armatus;* 548, *B. utahensis;* 549, *H. liponyssoides;* 550, *H. ambulans* form B; 551, *Macrocheles* sp.; 552, *H. pontiger;* 553, *Eulaelaps stabularis.*



Figs. 554-565. Peritremes. 554, *Hirstionyssus femuralis;* 555, *H. eutamiae;* 556, *H. affinis;* 557, *H. utahensis;* 558, *H. palustris;* 559, *Haemogamasus ambulans* form D; 560, *Hirstionyssus invaginatus;* 561, *H. invaginatus* variant; 562, *H. punctatus;* 563, *H. tarsalis;* 564, *Myonyssus montanus;* 565, *Hirstionyssus angustus.*



Figs. 566-576. Peritremes. 566, *Hirstionyssus bisetosus;* 567, *H. longichelae;* 568, *H. hilli* variant; 569, *H. triacanthus;* 570, *H. neotomae;* 571, *H. torus;* 572, *Ichoronyssus robustipes;* 573, *H. hilli;* 574, *H. isabellinus;* 575, *H. incomptus;* 576, *H. thomomys.*



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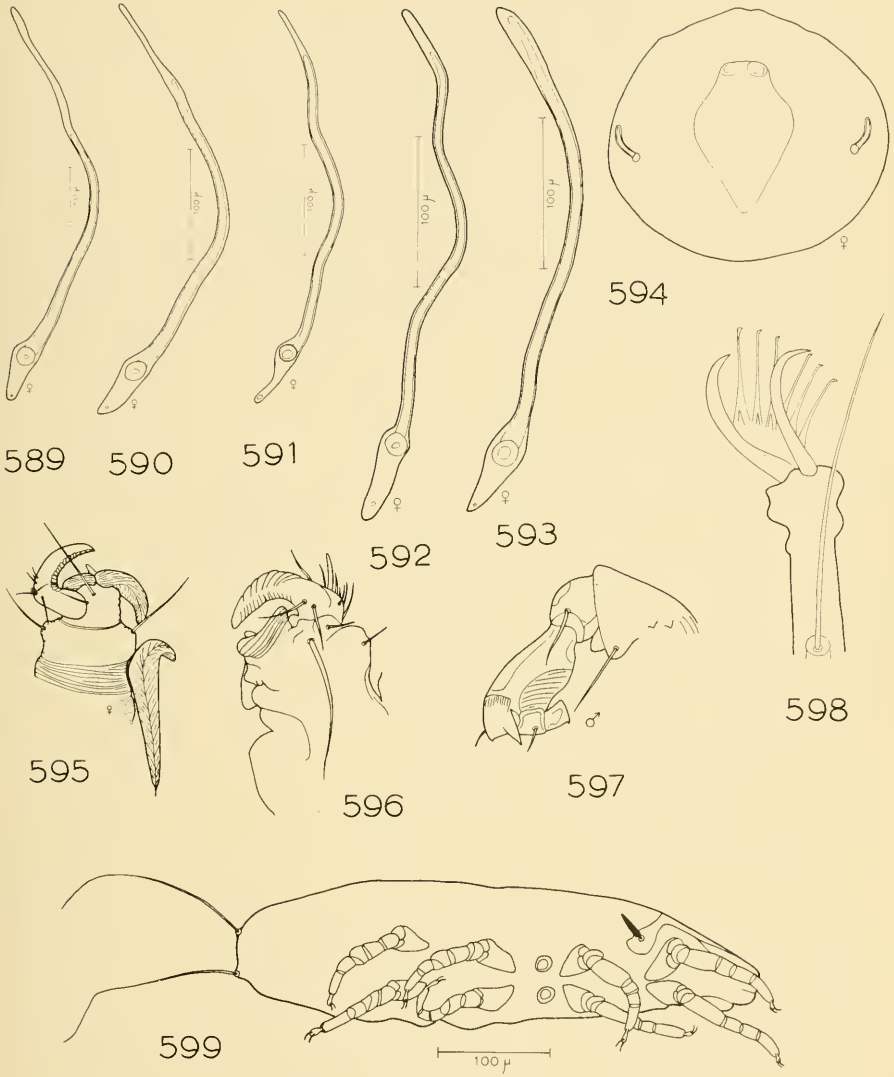

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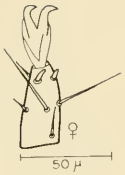

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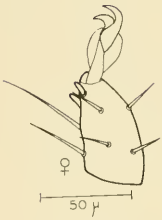

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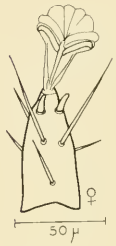

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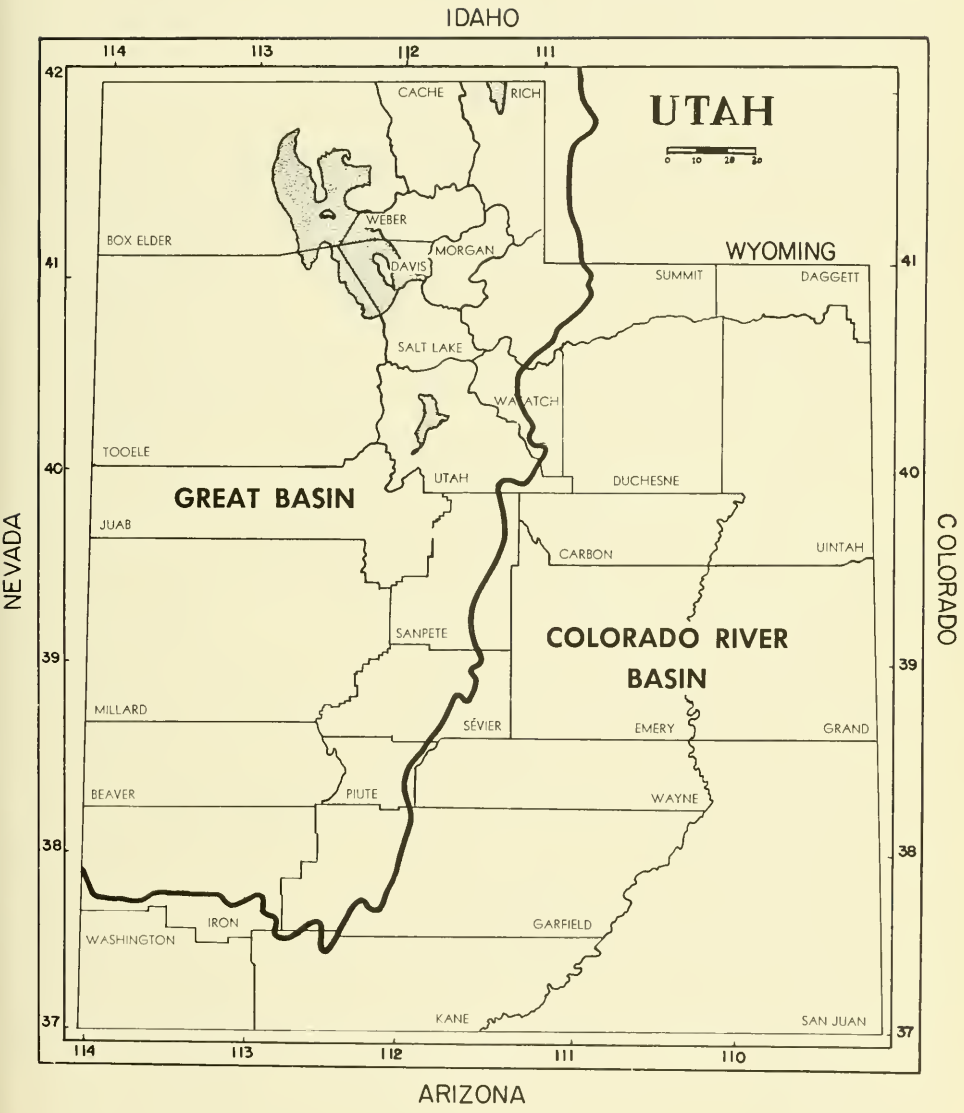

Fig. 615. Map of Utah showing counties and division into Great Basin and Colorado River Basin.

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Science Bulletin

RHYNCHOPHORA BEETLES OF THE NEVADA TEST SITE

by

VASCO M. TANNER

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RHYNCHOPHORA BEETLES OF THE NEVADA TEST SITE[1]

by

Vasco M. Tanner[2]

INTRODUCTION

It is interesting to contemplate the progress that is taking place in the accumulation of information and understanding of the large and interesting group of snout beetles, the Rhynchophora. Following the major contributions made by LeConte, Horn, Say, Casey, Blatchley, Leng, Fall, Schaeffer, and Dietz, there was a decided lull and lack of interest in the study of the weevils. Within the past 30 years, however, many new workers have been attracted to the study of the Curculionidae of this country. Attention has been turned to careful curating and amassing in permanent collections of the old and newly collected specimens of Nearctic species. Major contributions by recent workers which must be consulted when studying this insect complex have been made by such authorities, to name a few, as Pierce, Van Dyke, Buchannan, Ting, Sleeper, Warner (Mrs. Spilman), Kissinger, Burk, Gilbert, and Anderson.

Two timely and useful recent contributions are Arnett's "The Beetles of the United States, A Manual for Identification," and Kissinger's "Curculionidae of America North of Mexico, A Key to the Genera 1964." These bring together and make available information on the weevils that will greatly facilitate research work on this difficult group.

There is great need for careful internal as well as external morphological studies of the weevil genera. Without doubt, the more than 3,600 genera can be reduced in number and a better understanding of their phylogeny brought to light. Too little is known about the immature stages and food habits of the United States weevils. It is the aim of this study to classify those collected at the Nevada Test Site (Fig. 11) according to latest available studies and to report their seasonal abundance and plant hosts. No special effort was made to collect Rhynchophora; only specimens that were trapped along with other insects or were occasionally taken from plants came into this collection. The collecting extended from autumn, 1959 to and including the summer of 1965. A total of 310 specimens representing 28 genera and 44 species was collected.

The fauna of this southern portion of the Great Basin is typically Sonoran in its insect elements. The summers are hot and long; whereas the winters are mild and short. Allred, Beck, and Jorgensen (1963a) reported temperatures of 112° F in July. Van Dyke (1939) pointed out that the Sonoran fauna is a peculiar one, well adapted to its environment. The dominant groups of insects in this fauna are such coleopterous families as the Tenebrionidae or darkling beetles (Tanner and Packham, 1965), the Meloidae or blister beetles, and somewhat related Alleculidae and Oedemeridae, and a certain large element of broad-nosed weevils like the Brachyrhinae (Otorhynchinae) as well as numerous genera of Buprestidae or jewel beetles. Other dominant insects than the beetles which favor these areas are the Bombyliidae or bee flies (Allred, Johnson, and Beck, 1965) and the Asilidae or robber flies among the Diptera. The great portion of the adult beetles are nocturnal, burying themselves in the soil during the day, and most of their larvae are subterranean in habit. Many of the nocturnal forms are somber in color or with very little color, the diurnal forms often gray and many of them very hairy, as is true of many desert plants. Though so very distinct and highly modified, I am convinced that most of this fauna has been derived from the Neotropical or South American fauna. Species of the tribe Anthonomini which live mainly in the flowers, fruits, and seeds of plants are well represented.

The plant communities of the test site were determined and discussed by Allred, Beck, and Jorgensen (1963a, 1963b). They used two major types of vegetation at the test site which they divided into plant communities (Fig. 12). The Desert Scrub type was divided into the Larrea-Franseria, Gravia-Lycium, Coleogyne, Atriplex-Kochia, and Salsola communities. The Desert Woodland type was designated as one community, the Pinyon-Juniper. Some areas were not typical of the above plant communities, and

[1]Report B Y.U.-A.E.C. COO-1355-12. Field work completed under A.E.C. contracts AT(11-1)-780 and AT(11-1)-1320.
[2]Department of Zoology and Entomology, Brigham Young University, Provo, Utah

Allred *et al.* proposed that mountain areas, natural springs, reservoirs, and playas be grouped together as mixed communities.

In this study the weevil species are discussed under plant relationships, and the number of specimens collected, month and year of collection, and plant host or plant communities where collected are given. Specimens taken in can traps are related only to the plant community where trapped. This may not be entirely accurate since it does not account for the flight or movement of the specimens from contiguous areas.

Very little information, if any, on the life history of species of this study was obtained.

ACKNOWLEDGMENTS

I am indebted to many individuals who were associated with the collecting, preparing, and furnishing of ecological information on the weevils from the Nevada Test Site. This study was made possible by a grant to Brigham Young University from the Atomic Energy Commission, contract AT(11-1)-786. Drs. Dorald M. Allred and D Elden Beck, project directors, Department of Zoology and Entomology of Brigham Young University, have been most active in gathering data as outlined by the grant and very successful in getting the findings published. I acknowledge and thank the Atomic Energy Commission and Drs. Allred and Beck for financial support, facilities, and many kindnesses during this study.

Appreciation is also extended to Drs. H. R. Burk, Department of Entomology, Texas A & M University, who kindly furnished his opinion on some species of Anthonomini, and Harold J. Grant, Academy of Natural Science of Philadelphia, who made it possible for the author to compare and study many species of the Mason weevil collection at the academy. Mrs. Rose Ella Spilman, U.S. National Museum, and Mr. Hugh B. Leech, California Academy of Sciences, were helpful in providing loans and comments on specimens submitted to them. I also thank the preparators who, under the supervision of Drs. Allred and Beck, were most courteous and helpful in providing collection data and sifting out ecological information, and Mr. Douglas Hill of Brigham Young University who drew some of the illustrations used in this study.

LIST OF THE SPECIES

Two families of the Rhynchophora are represented. In the main I have followed Kissinger's (1964) taxonomic proposals as to subfamilies, tribes, and genera of the Curculionidae. He made a number of major changes in the subfamily and tribal sequence. This departure from the Leng Catalogue and Bradley Manual arrangement of higher categories will no doubt, if followed, be reflected in a new catalogue of the North American Coleoptera. I agree with the way Kissinger has dealt with the Otiorhynchinae of Leng. The new arrangement of the genera is far more natural and morphologically sound.

I have made use of the keys and of the genus and species characterizations of previous contributors to our knowledge of the species included in this study. The labeled drawing of *Calendra ochrens* Lec. (Fig. 1) may be useful in interpreting the morphological terms used in the keys and descriptions.

Family PLATYSTOMIDAE (ANTHRIBIDAE)

Subfamily Anthribinae

Tribe Anthribini

Trigonorhinus irregularis (Tanner)

Family CURCULIONIDAE

Subfamily Brachyrhininae

Tribe Peritelini

Thinoxenus nevadensis Casey
Thricolepis inornata Horn
Eucyllus vagans Horn
Eucyllus unicolor Van Dyke
Aragnomus hispidulus Casey

Subfamily Thylacitinae

Tribe Baryotini

Cryptolepidus leechi Ting

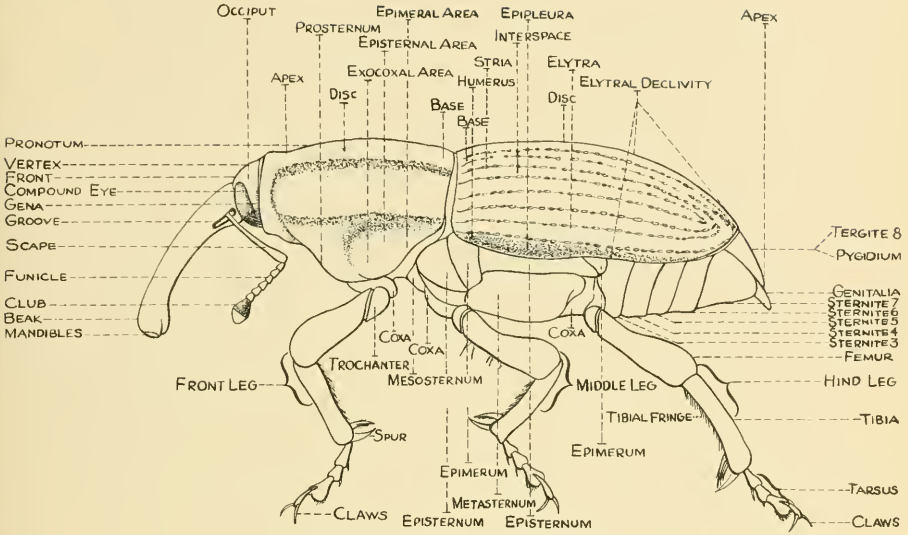

Fig. 1. *Calendra ochreus*, general morphology

Cryptolepidus nevadicus (Van Dyke)
Cryptolepidus aridus, new species
Cryptolepidus cazieri (Van Dyke)

Subfamily Leptopiinae
Tribe Ophryastini

Ophryastes varius (LeConte)
Ophryastes geminatus Horn

Tribe Leptopiini

Orinodema protracta Horn
Paracimbocera atra Van Dyke
Paracimbocera artemisiae Ting
Miloderes mercuryensis, new species
Dirotognathus sordidus Horn

Subfamily Cleoninae

Cleonus denticollis Casey
Cleonus lobigerinus Casey

Subfamily Erirhininae
Tribe Smicronychini

Smicronyx imbricatus (Casey)
Smicronyx sp.
Promecotarsus densus Casey

Subfamily Apioninae

Apion varicorne Smith

Subfamily Rhynchitinae

Auletobius humeralis Boheman
Auletobius sp.

Subfamily Myrmecinae

Myrmex lineata (Paseoe)

Subfamily Magdalinae
Tribe Magdalini

Magdalis lecontei subsp. *tenebrosa* Fall

Subfamliy Anthonominae
Tribe Anthonomini

Macrorhoptus hispidus Dietz
Anthonomus peninsularis Dietz
Anthonomus haematopus subsp. *confusus* Dietz
Anthonomus ornatulus Dietz
Anthonomus hirtus LeConte
Anthonomus sphaeralceae Fall
Anthonomus cycliferus Fall
Anthonomus tenuis Fall
Epimechus gracilis Fall
Brachyogmus ornatus Linell

Subfamily Tychiinae
Tribe Tychiini

Tychius prolixus Casey

Subfamily Cryptorhynchinae
Tribe Cryptorhynchini
Zascelis irrorata LeConte

Subfamily Ceutorhynchinae
Tribe Ceutorhynchini
Ceutorhynchus adjunctus Dietz
Ceutorhynchus tescorum Fall

Subfamily Baridinae
Tribe Madarini
Onychobaris mystica Casey
Onychobaris near *depressa* Casey

Subfamily Rhynchophorinae
Tribe Sipalini
Yuccaborus frontalis (LeConte)

KEY TO THE FAMILIES OF RHYNCHOPHORA OF THE NEVADA TEST SITE

Rostrum broad, flat, short, never separated from the front by a transverse impression. Labrum present. Antennae usually inserted under the sides of the front, slender, straight; segments 9 to 11 broader, more or less compressed, rarely forming a compact club. Labial palpi of three segments, slender, longer than in other Rhynchophora, the last segment of all palpi elongate. Base of pronotum always with a transverse elevated ridge. Pygidium exposed; notched to receive sutural apex of elytra. Middle coxal cavities broadly closed by sterna. Tarsi brushlike beneath, of four segments; the second emarginate, triangular; the third small, bilobed ..... Anthribidae

Rostrum variable in length, often long and curved downwards. Palpi short, rigid, nearly always concealed within the mouth. Head usually spherical. Antennae generally geniculate with a three-segmented club, usually ringed. Front coxal cavities closed behind. Elytra usually with a strong fold on the underside, limiting a deep groove into which the upper edge of the abdomen fits. Epipleura wanting. Five sternites, the first two closely united. Front and middle coxae rounded, the hind pair oval ..... Curculionidae

KEY TO THE SUBFAMILIES OF ANTHRIBIDAE OF THE NEVADA TEST SITE
(From Bradley, 1930, and Arnett, 1962)

Antennae inserted on the sides of the rostrum (Brachytarsinae) ..... Anthribinae

Antennae inserted on the front of the head, or dorsally at the base of the rostrum. Pronotal ridge basal ..... Choraginae

Tribe Anthribini

Since only one species of this family is included in this study, the tribe Anthribini to which it is assigned may be briefly characterized as follows: Antennae inserted on the sides of the rostrum; transverse ridge situated at the base, the surface behind it perpendicular.

KEY TO THE SUBFAMILIES OF CURCULIONIDAE OF THE NEVADA TEST SITE
(After Kissinger, 1964)

1. Trochanter long and somewhat cylindrical. Femur attached to apex of trochanter; base of femur distant from coxa. Antenna straight; funiculus with seven segments, segments 6 and 7 distinctly narrower than club ..... Apioninae

   Trochanter short and triangular. Femur attached to side of trochanter; base of femur closely adjacent to coxa 2

2. Antenna straight; rostrum generally lacking conspicuous scrobe to receive antenna. Prothorax not margined; elytra concealing tergites 1-5 3

   Antenna distinctly elbowed between scape and funicular segment 1; rostrum generally with apparent scrobe to receive scape of antenna. Tarsus with four distinct segments. Funiculus consisting of five to eight segments 6

3. Antenna with eleven segments, including distinct club composed of three segments. Prothorax not pedunculate at base. Mandible flattened, toothed on outer margin. Claw with basal process ..... Rhynchitinae

Rostrum not received into prosternal emargination, or, prosternum not a triangular plate in front of procoxae and rostrum usually slender and longer than head or tarsal claws toothed at base. Tarsal segment 3 usually strongly bilobed 4

4. Mandible lacking deciduous cusp, not scarred, either glabrous on lateral aspect or with few minute setae; mandible usually small in size. Rostrum slender, generally longer than prothorax; if rostrum shorter than prothorax then frons and rostrum lacking deep, median longitudinal groove, and scape not obviously extending beyond anterior margin of eye. Prothorax with margin more or less truncated, margin not produced into rounded lobe behind the eye; eye usually distant from anterior margin of prothorax, slightly round in outline. Prothorax lacking long setae projecting anteriorly from front margin adjacent to eye 5

Mandible with prominent scar indicating point of attachment of deciduous cusp, or else clothed laterally with many fine scales or setae; mandible large in size. Rostrum stout, quadrate in form, shorter than prothorax, rarely longer, often expanded laterally toward apex. Prothorax with anterior margin produced into prominent, rounded lobe adjacent to eye; eye usually partly covered by anterior margin of prothorax, mainly transverse in shape. Mandible with four or more large setae ..... Leptopiinae

5. Antennal scrobe vaguely defined posteriorly; scape usually passes over middle of eye when retracted next to head ..... Brachyrhininae

Antennal scrobe lateral, dorsal margin sharply defined, ventral and dorsal boundaries strongly bent ventrally so that scape usually rests below eye when retracted next to head ..... Thylacitinae

6. Scape not extending beyond hind margin of eye, generally fitting into scrobe; antenna generally inserted toward apex of rostrum; club uniformly clothed with erect, fine, short setae, first segment with distinct setae; if first segment is bare then funiculus with seven segments or prosternum with apical channel 7

Scape stout and long, projecting some distance past posterior margin of eye, not fitting into short antennal scrobe; inserted close to eye (exception to preceding statement: *Yuccaborus*); funiculus six segments, first segment of club large, virtually glabrous and polished. Large uncus on tibia 3 projects from anterior margin. Prosternum not channeled. Hind tarsal segment not bilobed (except *Yuccaborus*). Pygidium of male resembles that of female ..... Rhynchophorinae

7. Rostrum free, not received into deep, median sternal channel 8

Rostrum received into deep, median sternal channel in repose. Funiculus with six or seven segments. Eyes partially covered by prothoracic postocular lobes when rostrum is in repose. Pygidium covered by elytra. Tibia 1-3 armed with an uncus. Antennal club rather evenly clothed with pubescence. Tibia 3 with distinct apical comb of setae. Body lacking dense varnishlike coating. Tarsal segment 3 bilobed, usually distinctly wider than segments 1 and 2. Front coxae obviously separated by prosternum or claws toothed or connate ..... Cryptorhynchinae

8. Mesepimeron not ascending and not visible in dorsal view 10

Mesepimeron strongly ascending, truncated by elytral humeri and visible in dorsal view between prothorax and elytra; elytra not produced anteriorly over base of prothorax 9

9. Funiculus with seven segments. Claws simple, free, connate or with a single claw ..... Baridinae

Funiculus with six segments. Claw simple or toothed ..... Ceutorhynchinae

10. Front coxae contiguous, not separated by process of prosternum 11

Front coxae separated by complete process of prosternum; separation may be slight. Sterna unequal in length, 2 about as long or longer than 3 and 4. Claws simple. Tibia 3 definitely uncinate, praemucro if present small, less than one-half as long as uncus. Eyes narrowly separated by frons which is not wider than maximum diameter of club. Femur 1 toothed, sometimes strongly so. Elytra broadly exposing pygidium; elytra black, usually with a reddish area, lacking obvious vestiture. Tooth on femur 1 small and acute. Rostrum nearly subcylindrical. Metepimeron visible ..... Magdalinae

11. Suture between sterna 2 and 3 nearly straight, at most slightly produced backwards laterally, not reaching suture between sterna 3 and 4 12

Suture between sterna 2 and 3 strongly produced backwards laterally, reaching or passing suture between sterna 3 and 4. Claw with basal process. Hind coxa distant from margin of elytra. Rostrum definitely tapered apically ..... Tychiinae

12. Claws connate at base. Funiculus with seven segments. Elytron lacking acute subhumeral tubercle. Tibia lacking angulation on inner surface near middle 13

Claws free at base, simple, lacking basal process; sterna unequal in length. Front tibia with apex not produced into elongate, flat paddle; tibia 3 unarmed at apex or mucronate, mucro not more than one-half as long as claw; eyes well developed 14

13. Eye distant from anterior margin of prothorax; anterior margin of prothorax with long postocular vibrissae and not produced into postocular lobe. Vestiture fine, hairlike. Metepimeron visible, punctured and scaly at metepisternum ..... Cleoninae

Eye partially concealed by postocular lobe of anterior margin of prothorax; long postocular vibrissae absent. Rostrum obviously more slender than maximum width of femur 2, usually separated from frons by erect group of scales and transverse impression. Elytra usually with round or narrow scales. Eyes usually not contiguous ventrally ..... Erirhininae

14. Rostrum long and slender, more or less glabrous; width at insertion of antenna (in lateral view) much less than width of eye; rostrum longer than prothorax; eyes nearly round (subfamily in part) ..... Anthonominae

Rostrum stout, front coxae much closer to hind margin of prosternum than front margin, distance to front margin not less than two times as great as distance to hind margin; prothorax longer than wide, globose in middle, base much narrower than middle; tibia 3 uncinate; frons narrower than diameter of antennal club; scrobe directed toward ventral aspect of rostrum; body nearly glabrous (subfamily in part) ..... Myrmecinae

SYSTEMATIC AND ECOLOGICAL DISCUSSION

Family Anthribidae
Subfamily Anthribinae
Tribe Anthribini

Genus *Trigonorhinus* Wollaston

Reference. Wollaston, 1861:102.

Morphological characteristics. Genus *Trigonorhinus*. Valentine (1960), a specialist on this family, pointed out that the generic characteristics of this genus may be recognized in all the species assigned to the genus ". . . by their rostrum, the dorsal surface of which is progressively narrowed from base to apex, and by the shape of the apex itself which has the central portion distinctly produced beyond the corners and slightly emarginate. . . . The lobes of the third tarsal segment are separate, thus this segment appears profoundly emarginate. . . . Species of this genus are plant feeders like the majority of the family."

Trigonorhinus irregularis (Tanner)
Fig. 2

References. Tanner, 1934:285-286. Valentine, 1960:41-85.

Morphological characteristics. Form robust oval. Covered with loose whitish pubescence, except for brown checkering of prothorax and elytra. Head and rostrum blackish; mandible rufescent with whitish pubescence extending down over base of mandibles; labium distinct, brown and glabrous; eyes but slightly emarginate; scrobes reaching eye, antennal carina prominent, extending from upper margin of eye to base of mandible. Antennae rufescent, except segments of club which are brownish black; first two segments about equal; segments three to eight equal, but only about one-third as wide as first two; segments of club as long as segments three to eight. Prothorax wider than long; lateral carina extending forward only about one-third length of prothorax; decumbent coarse pubescence covers surface; distinct brownish spots on disc. Elytra wider at base than prothorax, with conspicuous brown patches of pubescence surrounded by white elongate scales. Legs rufescent and evenly covered with white pubescence; claws widely divergent with small tooth, about equidistant on claw. Under surface of the body covered with white scales. Length 1.9 mm, width 1.3 mm.

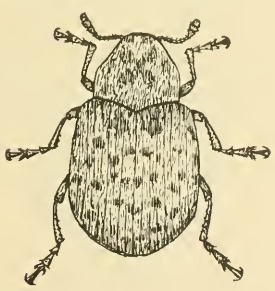

Fig. 2. *Trigonorhinus irregularis*, dorsal view

Plant relationship. One specimen was collected in July, 1965, on *Franseria acanthicarpa* in Area 17.

Comments. This species was described originally in the genus *Brachytarsoides* (Pierce, 1930) which was recently made a synonym of *Trigonorhinus* (Wollaston, 1961) by Valentine (1960); hence, the new combination.

In 1954, Dethlefsen described several species of *Trigonorhinus* from California and Nevada. I have been unable to relate *Trigonorhinus irregularis* to any of the species discussed in his paper. *Trigonorhinus nevadensis* agrees to some extent in color and pubescence, but it is much larger than *T. irregularis*. The species of this genus will no doubt be critically dealt with in the near future by Valentine, who is well prepared to do so.

Family Curculionidae
Subfamily Brachyrhininae
Tribe Peritelini

Genus *Thinoxenus* Horn

Reference. Horn, 1876:74.

Morphological characteristics. Genus *Thinoxenus* with mesopleural sclerites unequal, episternum larger and attaining elytra; first ventral suture arcuate; cotyloid surface of the hind tibiae squamose; scrobes lateral, not convergent, very shallow, not attaining the eyes; scape feebly arcuate.

Thinoxenus nevadensis Casey
Fig. 3

Reference. Casey, 1888:267.

Morphological characteristics. Casey described *Thinoxenus nevadensis* as an oblong-elongate convex species, clothed with small, rounded, dark brown scales; abdomen covered

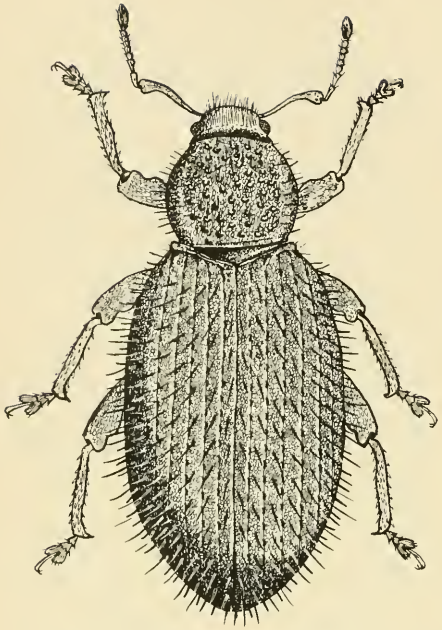

Fig. 3. *Thinoxenus nevadensis,* dorsal view

with crust of similar scales, intermixed with squamiform hairs. Head and rostrum conical, flattened; rostrum with short median stria in basal half; eyes small, very distant on sides; scrobes widely distant, narrow and deep near apex; antennae inserted nearly at apices of scrobes; first joint of funicle one-half longer than second. Prothorax one-half wider than long, wider than head; disc not densely punctate. Elytra emarginate at base; sides nearly straight and parallel; feebly striate. First ventral suture strongly arcuate; second segment as long as next two together. Legs densely squamose, with short semi-erect hairs. Length 5 mm, width 3.0 mm.

Plant relationship. One specimen was taken in a Pinyon-Juniper community, Area 12, in August, 1964.

Genus *Thricolepis* Horn

Reference. Horn, 1876:68).

Morphological characteristics. This genus is common throughout the Great Basin region. It has the following characteristics according to Pierce (1909): side pieces of mesosternum unequal, episternum large and attaining elytral margin, epimeron usually small; first ventral suture arcuate; cotyloid surface of hind tibiae glabrous; integument squamose; scrobes superior, convergent above; rostrum narrowed to tip, longer than head; scrobes very short, terminal.

Thricolepis inornata Horn

Reference. Horn, 1976:68-69.

Morphological characteristics. *Thricolepis inornata*, one of the three species of this genus found on the oaks, is common along the Wasatch Front and in the Great Basin. It has the following distinguishing characteristics: form oval and robust, head and rostrum larger than thorax, surface sparsely punctured and not densely scaly. Antennae prominent, rufotestaceous. Prothorax cylindrical, slightly wider than long, with deep punctures, sparsely scaly and with erect hairs. Elytra about three times as long as thorax, with closely placed punctures, intervals flat, short black erect setae, scales of pearly luster, and body surface black and shining. Length 3.6 mm, width 2 mm.

Plant relationship. One specimen was taken from *Quercus gambelii*, Area 12, in August, 1965.

Genus *Eucyllus* Horn

Reference. Horn, 1876:74.

Morphological characteristics. Genus *Eucyllus* with first ventral suture arcuate, cotyloid surface of hind tibiae squamose; scape arcuate, slightly twisted; scrobes lateral, not convergent, deep, attaining the eyes.

Specimens representing two species of this genus were collected at the test site. Van Dyke (1936:31-32) prepared the following key to separate the species of *Eucyllus*:

1. Larger species, 5.5 to 7.5 mm in length; bicolored; second funicular segment from three to four times as long as broad; setae of entire upper surface hispid, many times as long as broad and acute at apices ..... *vagans* Horn

   Smaller species, 5 mm or less in length; second funicular segment but little more than twice as long as broad; setae of upper surface very short and robust, squamose or club-like and blunt at apices 2

2. Bicolored, three brown stripes on pronotum and numerous brown patches on elytra; erect setae of upper surface club-like, several times as long as broad ..... *echinus* Van Dyke

Unicolored, cinereous; erect setae of upper surface peg-like or tubercular; but little longer than broad ..... *unicolor* Van Dyke

Eucyllus vagans Horn

Fig. 4

Reference. Horn, 1876:75.

Morphological characteristics. *Eucyllus vagans* is an elongate oval species, densely clothed with scales and grayish setiform hairs. Head and rostrum not as long as thorax, covered with cinereous and pale-brownish scales intermixed, and short erect hairs; prothorax cylindrical, slightly wider than long, disc sparsely punctured, densely scaly and with some hairs. Elytra twice as long as wide, finely striate, fine punctures on the striae, intervals flat; long erect hairs on each interval. Venter of body scaly, with some short setae. Legs with cinereous scales; femora with dark ring near tip. Length 7 mm, width 3 mm.

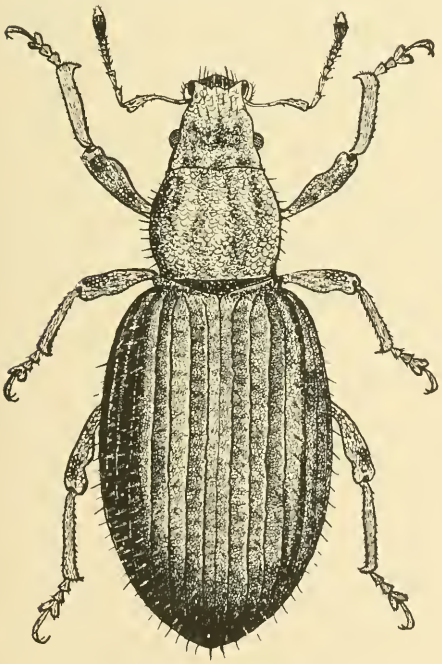

Fig. 4. *Eucyllus vagans*, dorsal view

Plant relationships. A total of 42 specimens was collected, mostly during 1961 (Table 1).

Table 1. Collection records of *Eucyllus vagans* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
1	Grayia-Lycium	April 1, May 2
5	Larrea	May 1, June 1, Sept. 2, Oct. 3, Nov. 3
	Lycium	Sept. 2, Nov. 1
6	Mixed	Nov. 1
10	Coleogyne	April 1, Aug. 1, Oct. 1, Nov. 1
12	Grayia-Lycium	June 1
	Pinyon-Juniper	Aug. 1
16	°*Eurotia lanata*	June 1
23	Mixed	Oct. 6, Nov. 6
28	Mixed	Feb. 2, Oct. 1, Nov. 1
Cane Springs	Mixed	May 1, Oct. 1

Eucyllus unicolor Van Dyke

Reference. Van Dyke, 1936:32.

Morphological characteristics. *Eucyllus unicolor* is a small species, unicolored, lacking brown stripes common to other two species, cinereous with erect setae which are peg-like or tubercular. Prothorax with sides less broadly rounded, elytra narrower with striae deeper and with closer punctures. Length 4.9 to 5.1 mm, width 2 to 2.1 mm.

Plant relationships. Four specimens were taken from a mixed community, Area 28, and two from Cane Springs (a mixed community), all in September and October, 1961.

Genus *Aragnomus* Horn

Reference. Horn, 1876:72.

Morphological characteristics. *Aragnomus*, a genus related to the genera *Thricolepis*, *Eucyllus*, and *Thinoxenus*, is distinctive because of an arcuate ventral suture. Cotyloid surface of hind tibiae glabrous; integument squamose; scrobes more lateral, not convergent above, and scape much shorter than flagellum.

Aragnomus hispidulus Casey

Reference. Casey, 1888:266.

Morphological characteristics. *Aragnomus hispidulus* is robust, covered with rounded, pale brown scales. Head wider than rostrum; rostrum longer than wide and dilated at tip. Antennal scrobes lateral, deep, nearly straight, but not reaching eyes; scape extending beyond anterior margin of prothorax, shorter than flagellum. Prothorax one-half wider than long, sides parallel, finely and sparsely punctate, each puncture with erect scale. Elytra slightly inflated, declivous at apex; one-third longer than wide, middle much wider than prothorax. Legs short and well covered with short erect scales. Length 5.5 mm, width 2.7 mm.

Plant relationships. Twenty-five specimens were collected, mostly during 1962 (Table 2).

Table 2. Collection records of *Aragnomus hispidulus* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
2	°*Coleogyne ramosissima*	Jan. 1, April 1
4	°*Grayia spinosa*	Nov. 1
5	°*Larrea divaricata*	May 1
12	Pinyon-Juniper	July 14, Aug. 7

Subfamily Thylacitinae
Tribe Barynotini
Genus *Cryptolepidus* Van Dyke

Reference. Van Dyke, 1936:91.

Morphological characteristics. Kissinger (1964) placed *Cryptolepidus* in the subfamily Thylacitinae which he characterized as follows: claws free; eyes in part encroaching upon dorsal area of head, frons narrower than rostrum; frons and dorsal surface of rostrum lacking deep median sulcus, with at most a broad, shallow, longitudinal depression; rostrum separated from frons by distinct transverse furrow or depression; dorsal aspect of tarsal segments with scales, tarsi clothed ventrally with coarse setae. Mentum concealing maxillae; frons lacking distinct tubercle above eye; eye visible in dorsal view; elytra with suberect, fine, acute setae.

The genus *Cryptolepidus* includes six species confined to southern California, Nevada, and Arizona. The main generic characters are no pubescence on ventral surface of tarsal segments, only bristle-like setae present. Third tarsal segment only slightly, if at all, larger than second. Postocular prothoracic lobes and vibrissae absent. Antennal scrobes deep and only slightly widened at posterior end.

Four species are known for Nevada and the test site. The following key modified from Ting's (1940)) study will separate them.

KEY TO SPECIES OF CRYPTOLEPIDUS

1. Elytral setae short and reclinate, not longer than one-fourth to one-half width of intervals; head slightly convex between eyes; pronotal sides faintly convex ..... *leechi* Ting

   Elytral setae long and suberect, as long or longer than width of intervals; head between eyes flat or concave; pronotal sides strongly convex 2

2. Pronotum not tuberculate or rugose 3

   Pronotum distinctly tuberculate and rugose 4

3. Base of rostrum with broad, somewhat arcuate, transverse constriction; pronotum as broad as long; elytral intervals flat; fore tibiae with six spinules and pale colored mucro at apex, exclusive of those in ventral comb ..... *nevadicus* (Van Dyke)

   Base of rostrum with well-defined basal constriction, with median longitudinal groove free from scales; head one-third wider than rostrum at base; corbel spinules amber, widely spaced, six in anterior, eight in mesothoracic tibial comb; setae white to golden, long, three times width of elytral intervals, sparsely placed, none on medial discal area, short on head and rostrum; antennal club reddish-brown; scales silvery; size 4 to 4.5 mm ..... *aridus* new species

Base of rostrum flat; pronotum one-fourth wider than long; elytral intervals slightly convex; fore tibiae with eleven spinules and black mucro at apex, exclusive of those in ventral comb . . . . . *planifrons* Ting

4. Dorsum of rostrum longitudinally convex between base and subapical area; median sulcus narrow, line-like; color brown . . . . . *cazieri* (Van Dyke)

Dorsum of rostrum longitudinally flat; median sulcus broad; color grey . . . . . *rugicollis* Ting

Cryptolepidus leechi Ting

Reference. Ting, 1940:147.

Morphological characteristics. Moderately elongate, clothed with white, imbricate, circular and ovate scales; rostrum with faint basal transverse constriction; narrow median sulcus; setae sparse and same length as those on head; subapical area with V-shaped glabrous region back of nasal plate. Head with area between eyes slightly convex. Prothorax with broad apical constriction; broader than long; disc punctate, but covered by crust of white scales; setae about same length as head setae. Elytral sides nearly parallel; intervals flat, striae fine, setae short. Spinules black, hind tibia with six teeth in distal comb and five teeth in anterior comb. Length 6.5 mm, width 3.0 mm.

Plant relationships. Two specimens were taken, one in a Larrea community, Area 5, in March, 1961, and the other in a Lycium community, Area 5, in February, 1961.

Comments. Ting points out that the salient characters of *C. leechi* are its extremely short setal vestiture whose length on the elytra is one-fourth to one-third the interval width; the slightly convex front between the eyes; and the nearly black tarsal bristles and corbel spinules.

Cryptolepidus nevadicus (Van Dyke)

Reference. Van Dyke, 1936:77.

Morphological characteristics. *Cryptolepidus nevadicus* is reddish-brown to black with gray and irridescent scales. Tarsal bristles and tibial spinules pale yellow in main, but light brown in some specimens. Rostrum broad, with transverse constriction at base; median sulcus narrow, extending from antennal articulation to posterior margin of basal transverse constriction. Pronotum smooth, as broad as long, sides convex; longer setae four times longer than head setae; no median sulcus. Elytral intervals flat; setae two and one-half times longer than interval width. Metepisternal suture visible at posterior end. Hind tibia with seven spinules in distal comb; anterior comb with five to seven spinules; however, number of spinules variable. Length 3.4 to 4.6 mm, width 2 mm.

Plant relationships. A total of 20 specimens was taken, mostly during 1961 and 1962 (Table 3).

Table 3. Collection records of *Cryptolepidus nevadicus* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
1	Grayia-Lycium	Jan. 1, Feb. 3, Mar. 8. April 2, May 2
5	Lycium	Feb. 1, Mar. 1
6	Atriplex-Kochia	Feb. 1, Mar. 2
17	°*Oenothera californica*	June 1
28	Mixed	Mar. 1
Cane Springs	Mixed	Mar. 3, April 2, Dec. 1

Cryptolepidus aridus, new species
Figs. 5, 6, 7

Morphological characteristics. Black. Antennal club reddish-brown, compact. Vibrissae absent. Scales on elytra imbricate, silvery with few brown to black intermixed in some specimens, with sheen which gives all specimens whitish color. Head and rostrum as long as prothorax; rostrum with median longitudinal groove free from scales; head one-third wider than rostrum at base, separated by well-defined basal constriction. Scrobes deep, terminating below eyes which are ovulate black and flattened; scape reaches posterior margin of eye; first joint of funiculus longer than second and third combined; club received in cupped seventh funicular segment. Prothorax wider than long, greatest width near apical region; postocular lobes and vibrissae absent. Dorsal surface covered with round, silvery white scales. Lateral surface with long setae. No median or lateral vittae. Elytra parallel, surface flat, striae fairly distinct, but punctation obscured by imbricate scales; setae

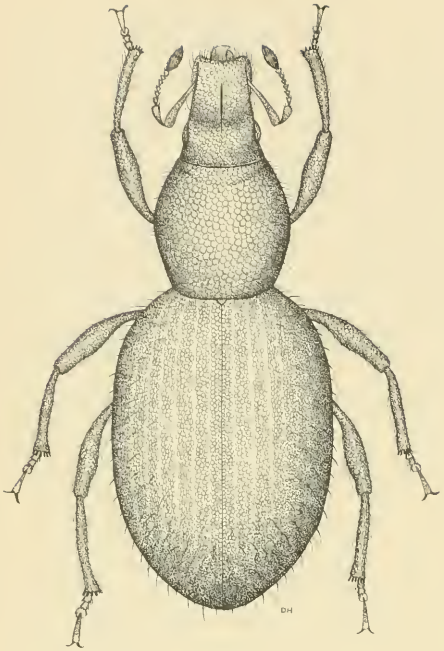

Fig. 5. *Cryptolepidus aridus,* dorsal view

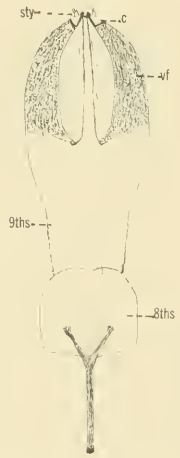

Fig. 6. *Cryptolepidus aridus,* female genitalia, ventral view. sty—stylus; c—coxite; vf—valvifer; 9ths—ninth sternite; 8ths—eighth sternite

similar in color and length to those on prothorax, but three times as long as ones on head and rostrum. Legs whitish, except for corbel spinules which are amber colored, and black ventral tarsal spines. Spinules of tibial comb widely spaced and short. Fourth segment of tarsus as long as other three combined. Claws widely separated and long. Aedeagus (Fig. 8) characteristic of *C. aridus,* but differs in a number of respects from that of other species of this genus. (See Ting, 1940).

Type locality. Nevada Test Site near Mercury, Nye County, Nevada. Collected by members of the Brigham Young University A.E.C. Project, 1960 to 1962. Holotype in the U.S. National Museum. Four paratypes in the entomological collection at Brigham Young University.

Plant relationships. Five specimens were taken as follows: two in a Grayia-Lycium community, Area 1, in May, 1960, and April, 1962; two in a Coleogyne community, Area 2, in January and March, 1961; and one in an Atriplex-Kochia community, Area 6, in February, 1961.

Comments. *Cryptolepidus aridus* is a small species. The corbels are open with widely spaced amber colored spinules. The small size and silvery-colored scales are distinctive.

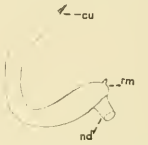

Fig. 7. *Cryptolepidus aridus,* spermatheca (receptaculum seminis). cu—cornu, distal portion of spermatheca; rm—ramus, portion of spermatheca receiving the seminal fluid; nd—nodulus, that part of the spermatheca attaching to the spermathecal gland

Cryptolepidus cazieri (Van Dyke)

References. Van Dyke, 1936b:73; Ting, 1940: 148.

Morphological characteristic. Oblong, robust, black, appendages rufous, densely clothed with imbricated, gray and light brown scales, latter forming median and lateral vittae on pronotum, and irregular patches on elytra. Rostrum with pronounced basal, transverse constriction; dorsum convex from base to nasal plate; narrow median sulcus; setae on rostrum and head same length; first funicular segment of antennae more elongate than in other species of genus; scrobes

nearer posterior end than in other species; nasal plate broadly and shallowly emarginate. Pronotum tuberculate, broader than long. Elytra one-fourth longer than broad, rounded at base and apex, flattened, setae arranged in two or three irregular rows per interval. Hind tibia with distal comb with 10 spinules; anterior comb with five spinules. Scales dense beneath; first and second ventral segments slightly concave. Length 5.1 mm, width 2.8 mm.

Plant relationship. One beetle was taken in a Lycium community, Area 5, in March, 1961.

Comments. *Cryptolepidus cazieri*, according to Ting (1940), may be easily distinguished from the other described species of this genus as follows: pronotum tuberculate; dorsum of rostrum convex from base to nasal plate; only species predominantly tan to brown.

Subfamily Leptopiinae
Tribe Ophryastini

Genus *Ophryastes* Schoenherr

References. Schoenherr, 1833:508; LeConte and Horn, 1876:30; Fall, 1907:260, 1910:189; Davis, 1947:483-551; Kissinger, 1964:31.

Morphological characteristics. The subfamily Leptopiinae, according to Kissinger, has elbowed antennae with compact club, rostrum grooved for their reception; rostrum not received into prosternum; rostrum never long and slender; tarsi usually dilated, third segment bilobed, brush-like beneath; mandibles with deciduous cusp, leaving scar; prothorax with anterior margin produced into prominent, rounded lobe adjacent to eye; eye partly covered by anterior margin of prothorax; mandible with four or more large setae.

The tribe *Ophryastini* is characterized by well-developed ocular lobes, eyes elongated, transverse, accuminate beneath, and in part covered; mentum large, covering maxillae; scrobes directed beneath; rostrum large, quadrangular; eyes narrow and acute below, partially concealed by ocular lobes.

If the species listed in the Leng Catalogue under the genera *Eupagoderes* and *Ophryastes* are now to be considered in the genus *Ophryastes*, the characteristics as presented by Kissinger (1964) should be followed: antennal funiculus and dorsal portion of tarsal segments 1 to 3 clothed with decumbent, usually broad scales; rostrum trisulcate—if sulci are obliterated then tarsal segments in basal half not dotted ventrally with coarse setae; antennal scrobe usually well defined, dorsal margin rather straight; hind coxae separated by distance not greater than width of coxa; suture between sterna 1 and 2 straight; elytra regularly 9 to 10 striate, not nodose in apical fourth; lateral rostral sulcus not abruptly turned laterally towards antennal scrobe; prothorax wider at base than apex; sternum 2 shorter than 3 and 4 combined; tarsal segment 3 pubescent beneath and broadly bilobed, at least in male; prothorax more or less tuberculate laterally; apex of tibia 3 with two rows of setae, corbel enclosed.

The two species of *Ophryastes* collected at the test site may be separated from other species as follows:

Rostrum with well-developed median sulcus; thorax finely and sparsely punctate, tibiae not denticulate within; lateral sulcus of rostrum short, linear; elytral striae fine, intervals flat, punctation fine; length 6 to 12 mm ..... *geminatus* Horn

Rostrum without median sulcus; thorax more coarsely and closely punctate; tibiae, at least anterior, denticulate within; lateral sulci of rostrum longer, arcuate, convergent basally; elytral striae closer together, deeper punctures; length 7 to 14 mm ..... *varius* (LeConte)

Ophryastes varius (LeConte)

Reference. LeConte, 1853:439-448.

Morphological characteristics. Dorsum of rostrum and front continuous, without interruption by transverse impression at base of rostrum; rostrum without median sulcus, convex and broadened at apical portion of rostrum. Lateral sulci of rostrum long, arcuate and convergent basally. Surface sparsely punctured, covered with white scales. Prothorax coarsely and closely punctate. Surface covered with silvery white scales, with median and lateral plumbeous stripe. Elytra broadest behind middle, finely striate with coarse punctures widely separated, surface covered with white scales interspersed with plumbeous ones which in some species form spots or vittae. Legs and body beneath clothed with white scales. Length 5.5 to 10.5 mm.

Plant relationships. A total of 63 beetles was taken. Most specimens were taken during 1960 and 1961, with others collected in other years from 1959 to 1965 (Table 4).

Table 4. Collection records of *Ophryastes varius* at the Nevada Test Site.

Area	Plant Host* or Community	Month and Number of Specimens
1	Grayia-Lycium	Mar. 2, April 7, May 6, June 3
4	Grayia-Lycium	Mar. 1, April 2, May 3, June 1, Nov. 1
5	**Larrea divaricata*	May 1, June 1, July 10, Aug. 1
	Lycium	Mar. 1, April 1, May 3
6	Atriplex-Kochia	April 1, May 7, June 1
10	**Larrea divaricata*	July 1
	Mixed	Aug. 2
12	**Juniperus osteosperma*	June 1
	Pinyon-Juniper	July 1
16	**Atriplex canescens*	Aug. 1
26	Larrea	July 1
28	Mixed	May 1, June 1
Cane Springs	Mixed	April 1

Ophryastes geminatus Horn

Reference. Horn, 1876:35.

Morphological characteristics. Rostrum with slight interruption by transverse impression at base of rostrum; median sulcus variable in impression; lateral sulci short and varying in depth; covered with white scales, except for small plumbeous spot in front of eyes and at base of scrobes. Prothorax wider than long, median line rather impressed, disc coarsely punctate, covered with white scales except for plumbeous stripes on each side. Elytra one-third longer than wide, striae fine with small punctures covered with plumbeous scales which gives vittate appearance in most specimens. Legs and body beneath covered with white scales intermixed with plumbeous ones. Length 6.5 to 12 mm.

Plant relationships. A total of seven specimens was taken. Two were from a Grayia-Lycium community, Area 10, in June, 1964; one on *Grayia* sp., Area 4, in June, 1960; one on *Atriplex canescens*, Area 26, in June, 1965; one on *Chrysothamnus* sp., Midvalley, in June, 1965; and two on *Larrea divaricata*, Area 5, in June and September, 1961.

Tribe Leptopiini

Genus *Orimodema* Horn

Reference. Horn, 1876:43.

Morphological characteristics. Genus *Orimodema* with seventh segment of flagellum distinct from club; third tarsal segment broader than second, tarsi densely pubescent beneath; scrobes deep, well defined, strongly arcuate, passing beneath at distance from eyes; first ventral suture arcuate; second sternite usually as long or longer than third plus fourth; vestiture squamose but not intermixed with setae or pubescence; anterior tibiae denticulate within; nasal plate depressed, but not sharply defined.

Orimodema protracta Horn

Reference. Horn, 1876:44.

Morphological characteristics. The species *O. protracta* is elongate, densely covered with brownish scales intermixed with grayish small ones; head and rostrum as long as thorax. Prothorax cylindrical, broadest near apex; elytra elongate, base not wider than prothorax; disc feebly convex; feebly striate, intervals flat, densely covered with brownish-gray scales. Under surface densely clothed with brown and gray scales. Tibiae sparsely fimbriate. Length 10 mm, width 3 mm.

Plant relationship. One specimen was taken in a Pinyon-Juniper community, Area 12, in August, 1962.

Genus *Paracimbocera* Van Dyke

References. Van Dyke, 1938:1; Ting, 1940: 136.

Morphological characteristics. Species of the Leptopiini tribe have tarsal segments on ventral surface with bristle-like setae only or with greatly reduced pubescent tufts at apices; last segment of funiculus closely applied to base of antennal club. The genera of this tribe are fairly common and found mainly in the western United States.

The genus *Paracimbocera* proposed by Van Dyke (1938) has been characterized by Ting (1940) as follows: small tufts of pubescence present at apices of tarsal segments. Third tarsal segment generally distinctly larger than second (both characters much more pronounced on male specimens); antennal scrobes shallow and greatly widened at posterior end. Postocu-

lar prothoracic lobes prominent; pubescent tarsal tufts in both sexes present only on third segment of all tarsi.

The two species of this genus known for the test site may be separated, by the aid of Ting's (1940) key, from other species as follows:

Elytral setae length on declivity four times width of intervals; three to four irregular rows of setae per interval on declivity; tarsal bristles and corbel spinules dark brown, nearly black; metaepisternal suture distinct . *atra* Van Dyke

Elytral setae length on declivity two times width of intervals; two or three irregular rows of setae per interval on declivity; tarsal bristles and corbel spinules reddish brown; metaepisternal suture obscure ..... *artemisiae* Ting

Paracimbocera atra Van Dkye

Reference. Van Dyke, 1938:2.

Morphological characteristics. Black and elongate; head, prothorax and elytra densely clothed with black scales, those of head and prothorax granular white; scales of elytra flat and closely set; elytra with long pile, denser on declivity, whitish to fulvous, underside of body with mixture of whitish and plumbeous scales and setae. Length 5 to 7.5 mm.

Plant relationships. Eight specimens were taken from 1961 through 1965 as follows: four in a Grayia-Lycium community, Area 10, in June; one from *Ephedra nevadensis*, Area 6, in June; and three in a Pinyon-Juniper community, Area 12, in July and August.

Paracimbocera artemisiae Ting

Reference. Ting, 1940:139.

Morphological characteristics. Body color gray and black mottled; with black irregular vitta along second elytral interval. Tarsal bristles and tibial spinules reddish brown. Rostrum transversely constricted at base. Prothorax wider than long; surface with scales raised, giving slight tuberculate appearance; setae shorter than elytral setae. Elytral striae fine; intervals flat, setae about length of interval widths; setae on declivity twice length of intervals width. Length 5 to 7 mm.

Plant relationships. Nine beetles were taken from 1960 to 1962 as follows: two in a Larrea community, Area 5, in January and February; one in a Lycium community, Area 5, in March; two in a Coleogyne community, Area 10, in February and May; one in a Grayia-Lycium community, Area 10, in May; one in a Pinyon-Juniper community, Area 12, in August; one in an Artemisia community, Area 14, in March; and one in a mixed community, Cane Springs, in March.

Genus *Miloderes* Casey

Reference. Casey, 1888:252.

Morphological characteristics. The genus *Miloderes* now placed in the tribe Leptopiini has small tufts of pubescence present at the apices of tarsal segments. In male specimens third tarsal segment generally distinctly larger than second. Antennal scrobes deep and only slightly widened at posterior end. Postocular prothoracic lobes absent or only slightly evident. Pubescent tufts present in males at apices of basal three tarsal segments on fore legs. Rostral length slightly less than distance between eyes. Antennal funicular segments one to six not cupped at apices. Postocular lobes slightly evident.

KEY TO SPECIES OF MILODERES

(After Ting, 1940:151)

Color brown and silvery gray. Fore tibiae with outer apical portion evenly rounded. Scales of pronotum and elytra with central punctures .. *setosus* Casey

Color brown to sienna with white scales in irregular pattern on head and elytra, scales without central punctures. Prothoracic tibae rounded apically; 12 to 13 spinules on middle tibia; black vestiture, sparse setae ..... *mercuryensis*, new species

Color uniform green. Fore tibae with outer apical portion elongated. Scales of pronotum and elytra without central punctures ..... *viridis* Pierce

Miloderes mercuryensis, new species
Figs. 8, 9

Morphological characteristics. *Miloderes mercuryensis*, one of the three species ascribed to this genus, may be separated from the other two as follows: size 4 to 4.3 mm; brown to sienna with white scales in irregular pattern on head and elytra. Reddish-brown scales on margins of prothorax, on legs, especially tarsi and antennae. Rostrum wider than long with transverse impression just slightly posterior to antennal articulation, with median fovea on transverse impression. Pronotum broader than long, greatest width near apex; postocular lobes present, rounded opposite eye, with long, golden colored vibrissae which reach eye; setae on head and between closely arranged round punctures. Elytra with closely placed, deep strial punctures; setae length three to four times width of intervals. White scales irregularly arranged, thus making mottled white and brownish pattern; sides parallel with rounded humeral angle. Prothoracic tibiae rounded apically; third segment of tarsus broad, deeply emarginate; under-surface covered with white setae. Middle tibiae with 12 to 13 spinules. Posterior tibia with nine spinules, corbels open.

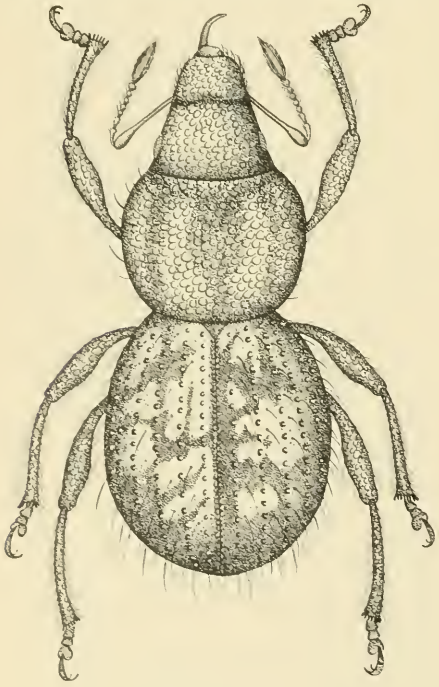

Fig. 8. *Miloderes mercuryensis*, dorsal view

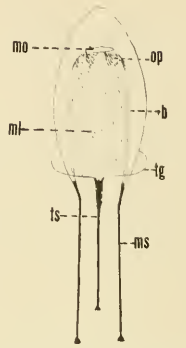

Fig. 9. *Miloderes mercuryensis*, aedeagus, ventral view. mo—median orifice; op—orificial plate; b—baculum; ml—median lobe; tg—tegmen; ts—tegminal strut; ms—median strut

The small size, color, scales without central punctures, short rostrum, 12 to 13 spinules on middle tibia, black vestiture, sparse setae, and shorter length than *M. sctosus* and *M. viridus* characterizes *M. mercuryensis*. The male genitalia (Fig. 9) is distinctive.

Type locality. Nevada Test Site, near Mercury, Nye County, Nevada. Collected by members of the Brigham Young University A.E.C. Project, 1961 to 1965. Holotype male in the U.S. National Museum. Two paratypes in the entomological collection at Brigham Young University.

Plant relationships. One specimen was taken from *Sphaeralcea ambigua*, Area 5, in June, 1964; one from *Grayia spinosa*, Area 26, in June, 1965; and one from a pit-can trap on the Jackass Flats approach road in a mixed plant association within the Larrea-Franseria community.

Comments. Figure 8 shows the cusp in place on the tip of the mandible of one of the specimens. This is a most interesting species.

Genus *Dirotognathus* Horn

Reference. Horn, 1876:79.

Morphological characteristics. This monotypic genus has ocular lobes, eyes elongate, transverse, acuminate beneath, and at least in part covered; mentum small, not retracted;

maxillae free; scrobes feebly angled, rapidly evanescent.

Dirotognathus sordidus Horn

Reference. Horn, 1876:80.

Morphological characteristics. *Dirotognathus sordidus* is oval, robust in form; covered with dark cinerous scales with short, decumbent, dark brown setae. Head and rostrum as long as thorax which is oval, broader than long. Elytra broadly oval, broader at base than thorax, finely striate; intervals flat. Body beneath and legs less densely scaly and very sparsely hairy. Length 5.2 mm, width 3 mm.

Plant relationship. Six specimens were collected in a Pinyon-Juniper community, Area 12, during June, July, and August, 1961.

Subfamily Cleoninae

Tribe Cleonini

Genus *Cleonus* Schoenherr

Reference. Schoenherr, 1826:145.

Morphological characteristics. The genus *Cleonus* may be characterized as follows: beak not dilated at tip; gular peduncle shorter than in *Lixus;* front and middle tarsi broad, third segment at least spongy and bilobed; hind tarsi hairy beneath first division, but broad and spongy in second; pubescence in longitudinal stripes, no transverse or oblique bands. Body elongate.

Blatchley and Leng (1916:329) observed that it is difficult to set forth in a key any definite characters which sharply define the two genera, *Cleonus* and *Lixus*.

Cleonus denticollis Casey

Reference. Casey, 1891:180.

Morphological characteristics. *Cleonus denticollis* is narrow to slightly robust, somewhat depressed above, elongate-suboval; black, densely clothed with short, recumbent, squamiform pubescence, cinereous to ferruginous in color; some sparse, short erect hairs; head sparsely punctate; beak shorter than prothorax, broadly bisulcate, densely pubescent above, median carina narrow but not acute, moderately elevated. Prothorax one-fourth wider than long, widest at anterior lateral tubercles which are very pronounced; sides behind them parallel to base, latter broadly cusped in middle, wider than apex; disc coursely foveolate, sides covered with white pubescence; middle sparsely clad. Scutellum inconspicuous. Elytra two-thirds longer than wide; humeri not prominent; disc with elevated alternate intervals; pubescence denuded on spots at basal portion of each elytron and along suture near apex in some specimens. Abdomen densely pubescent. Legs moderately stout, femora feebly annulate at apical third. Length 10.0 to 10.2 mm., width 4.0 to 4.2 mm.

Plant relationships. A total of 152 specimens was taken, mostly in 1960 and 1961 (Table 5).

Table 5. Collection records of *Cleonus denticollis* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
1	Grayia-Lycium	Jan. 1, Mar. 48, April 15, May 3, June 5, July 22, Aug. 5, Sept. 3, Oct. 2
	Salsola	Mar. 1, July 6, Aug. 2, Sept. 1, Nov. 2
4	Grayia-Lycium	April 1, Oct. 1
5	Larrea	June 8, July 4, Aug. 8, Oct. 1
6	Atriplex-Kochia	June 1
10	Coleogyne	July 1
	°*Hymenoclea fasciculata*	July 7
	°*Larrea divaricata*	July 1
28	Mixed	Feb. 1, July 1, Aug. 1

Cleonus lobigerinus Casey

Reference. Casey, 1891:191.

Morphological characteristics. Casey characterized *C. lobigerinus* in this manner: body slender and convex, integument feebly shining, pubescence cinereous, a broad discordal anteriorly constricted spot denuded along middle, marginal vitta on pronotum, also denuded on second, sixth and eighth elytral intervals. Head transversely impressed between eyes, rostrum rather long, feebly carinate, subequal in length to prothorax. Prothorax nearly as long as wide, apex broadly bisinuate, narrower than base, latter angularly lobed in middle, sides convergent from base to apex; disc coarsely punctate, deeply impressed in basal third, slight evidence of being carinate anteriorly. Elytra more than two times as long as wide; sides parallel and nearly straight, disc with deep approximate punctures. Abdomen and legs densely pubescent with few sub-denuded punctures. Length 8.9 mm, width 4 mm.

Plant relationships. Three specimens were taken as follows: one in a Grayia-Lycium com-

munity, Area 10, in June, 1964; one in a Salsola community, Area 7, in July, 1962; and one from *Atriplex canescens*, Area 16, in August, 1964.

Subfamily Erirhininae
Tribe Smicronychini

Genus *Smicronyx* Schoenherr

Reference. Schoenherr, 1843:313.

Morphological characteristics. The genus *Smicronyx* has tibia 3 unarmed or with spine less than one-half as long as tarsal claw; body lacking waterproof covering. Prosternum with coxae situated much closer to hind margin than to front margin; rostrum distinctly longer than head (in lateral view); scape not reaching anterior margin of eye; tarsal claws connate at base; femora unarmed; prothorax with postocular lobes; tarsal segment 4 shorter than segments 1 to 3 combined.

Smicronyx imbricatus (Casey)

References. Casey, 1892:391-392; Anderson, 1962:203-305.

Morphological characteristics. Rostra of both sexes black to piceous, slender and curved; squamose, punctate from base to near apex in male and female. Head black, squamose; antennae piceous, with pale brown scales. Prothorax black, sides subparallel; evenly covered with deep rounded punctures; scales ovate, white at sides and along midline, medium to light yellowish-brown elsewhere; prosternum deeply emarginate, not concave. Elytra black, intervals covered with imbricate elliptical scales, mostly white in humeral regions, light or medium brown with scattering of white posterior to humeral regions. Underside of thorax and abdomen black covered with ovate, white scales having violet to bluish irridescence. Femora reddish, covered with elongate and ovate, pale brown to white scales. Tibiae black. Third segment of tarsi broader than first two; fourth segment extending beyond third; claws connate near base. Length 2 to 2.4 mm, width 0.70 to 1.00 mm.

Plant relationships. A total of 54 specimens was taken, mostly during 1962, 1964 and 1965 (Table 6).

Table 6. Collection records of *Smicronyx imbricatus* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
5	°*Lycium pallidum*	July 1
	Larrea	July 1
12	°*Juniperus osteosperma*	June 4, July 5
	°*Pinus monophylla*	June 8, July 5, Aug. 7
	°*Chrysothamnus viscidiflorus*	Aug. 1
	°*Chrysothamnus nauseosus*	Aug. 1
	°*Ribes* sp.	Aug. 2
16	°*Artemisia tridentata*	July 1
	°*Argemone corymbosa*	June 1
	°*Eurotia lanata*	June 1
	°*Mentzelia albicaulis*	June 1
	°*Sallugia paradoxa*	June 2
	°*Pinus monophylla*	June 2
17	Unknown	Aug. 1
18	°*Grayia spinosa*	June 1
	°*Pinus monophylla*	June 2
	°*Juniperus osteosperma*	June 3
	°*Gutierrezia microcephala*	Aug. 1
23	Mixed	July 1
26	°*Atriplex canescens*	June 2
	°*Pinus monophylla*	June 1

Smicronyx sp.

Specimens of *Smicronyx* not referred to a species were taken at the test site. They are very similar to *S. cognatus* Dietz, now considered as a synonym of *mucidus* Dietz.

Plant relationships. Three specimens were collected in July, 1962, as follows: one from *Artemisia tridentata*, Area 14; one in a Larrea community, Area 5; and one in a mixed community, Area 23.

Genus *Promecotarsus* Casey

Reference. Casey, 1892:408.

Morphological characteristics. Body cylindrical, convex, longer and with more glabrous tarsi having small third segment, fourth segment very long and subequal in length to entire remainder. Vestiture dense over entire body, consisting of small imbricated scales, with recurved, subrecumbent setae on each strial interval. Rostrum constricted at base, head spherical, eyes oblong. Prothorax constricted at apex, ocular lobes more or less distinct. Scutellum small. Abdomen flat, second segment as long as the next two and not quite as long as fifth.

The test site species may be separated from others as follows:

1. Tarsal claws subparallel; prothorax much wider than long, with ocular lobes prominent ..... *fumatus* Casey

   Tarsal claws widely divergent; prothorax very nearly as long as wide; ocular lobes not prominent 2

2. Prothorax abruptly, deeply constricted near the apex, latter but slightly narrower than base ..... *maritimus* Casey

   Prothorax gradually more strongly narrowed and broadly, feebly constricted toward apex, latter scarcely more than two-thirds as wide as base .. *densus* Casey

Promecotarsus densus Casey

Reference. Casey, 1892:410.

Morphological characteristics. *Promecotarsus densus* is robust, subcylindrical, convex, black, densely clothed with oval, whitish overlapping scales, with distinct recurved setae. Head glabrous, constriction deep; beak slender, polished, rugosely punctate near base, almost three-fifths as long as elytra; antennae inserted beyond basal third, second funicular segment about as long as next two; club compact and shining toward base. Prothorax wider than long, sides parallel, convergent and constricted at apex; disc convex and very densely punctate throughout. Elytra at base about one-fourth wider than prothorax, one-half longer than wide; striae indicated by fine but sharply defined partings of dense crust of scales. Legs stout, tarsi long, divergent, connate at base. Length 2.4 mm, width 1.1 mm.

Plant relationships. Three specimens were collected in 1964 and 1965 as follows: two from *Artemisia tridentata* in August, and one from *Juniperus osteosperma* in July, all in Area 12.

Subfamily Apioninae

Genus *Apion* Herbst

Reference. Herbst, 97:100.

Morphological characteristics. Weevils of the subfamily Apioninae are characterized by having straight antennae, scrobes wanting; segments of antennae club compactly united; pygidium concealed; trochanters large, femora attached to apex; form pear-shaped. Small, not over 4.5 mm.

Two genera constitute this subfamily in the United States. The genus *Apion* may be distinguished from *Podapion* as follows: front femora not stouter than others; antennal club large, last segment larger than preceding.

Apion varicorne Smith

Reference. Smith, 1884:60.

Morphological characteristics. The only species of the genus *Apion* collected on the project at the test site is *varicorne*. It is black in color, covered with dense white pubescence. Antennae black except basal segment which is yellow; rostrum of female longer than that of male; intervals of elytra flat. Length 1 to 1.3 mm.

Fall (1898:160) discussed several varieties of this species. Kissinger (1964:32) placed *varicorne* in a group with three other species which occur throughout the western and southern United States, Mexico and Guatemala.

Plant relationships. Fourteen specimens were collected. Four were taken from *Dalea polyadenia* near Buckboard Mesa in July, 1965; five from *D. polyadenia* in Jackass Flats in August, 1965; four from *D. polyadenia* and one from *Eriogonum nodosum* near Tippipah Spring in August, 1965.

Subfamily Rhynchitinae

Auletobius humeralis Boheman

Reference. Boheman 1859:117.

Morphological characteristics. Three-fourths longer than wide; black, with elytra reddish-brown, except for narrow black line along suture; punctation fine; pubescence sparse, short, semi-erect, whitish. Head with occiput wider than long, feebly convex between eyes; punctation between eyes shallow, polished, eyes large and prominent. Rostrum as long as thorax and occiput, slightly arcuate behind base of antennae; antennae inserted within basal third of beak, two basal segments stout, others small; club large, very loosely jointed. Prothorax widest at basal third, one-third wider than long; base broadly and feebly arcuate; disc feebly convex, scutellum large. Elytra broadly and separately rounded at apex, one-half longer than wide, two-

thirds wider than prothorax; disc convex, impressed along suture; claws armed with tooth. Length 2.1 mm.

Plant relationship. Two specimens were collected in June, 1965, on *Ephedra nevadensis* in the environs of Cane Springs.

Auletobius sp.

Represented by three specimens. Color of head and body bluish black with sheen; rostrum and legs rufus. Size 2 mm.

I am unable to determine this species. It does not agree with any described species. I have before me specimens of all the species listed in Leng's catalogues except *mariposae* Zimmerman and those described by Voss.

One specimen was taken from *Ephedra nevadensis* near Cane Springs in June, 1965, and two specimens from *Chrysothamnus viscidiflorus* on Rainier Mesa in August, 1965.

Subfamily Myrmecinae

Genus *Myrmex* Sturm

Reference. Sturm, 1826:172.

Morphological characteristics. Members of the subfamily Myrmecinae to which the genus *Myrmex* belongs have tibiae that are not fossorial; rostrum free, not received by prosternum; humeri not truncated by protruding mesopleura; lateral angles of first sternite covered by elytra; beak usually at least as long as prothorax; gular peduncle usually long; sternites nearly equal, or first longer; claws usually more or less dentate; prothorax pedunculate; form ant-like.

Four genera in this tribe may be separated by the following key (Kissinger, 1964:50-51):

KEY TO THE GENERA OF MYRMECINAE

1. Front coxae inserted near middle of prosternum, coxae more or less equidistant from anterior and posterior margins of prosternum; inner margin of mandible toothed 2

   Front coxae much closer to hind margin of prosternum than to front margin, distance to front margins more than three times as great as distance to hind margin; mandible slender, triangular in outline, inner margin with minute basal tooth; rostrum slender, very long; femora clavate, with large triangular tooth ..... *Erodiscus* Schoenherr

2. Elytra elongate oval, humeri well developed 3

   Elytra ovate, rounded, humeri absent ..... *Oopterinus* Casey

3. Femora toothed; male lacking dorsal excavation on rostrum; length more than 3.0 mm ..... *Myrmex* Sturm

   Femora not toothed; male with dorsal excavation on rostum; length less than 3.0 mm ..... *Micromyrmex* Sleeper

Myrmex lineata lineata (Pascoe)

Reference. Pascoe, 1872:454.

Morphological characteristics. *Myrmex l. lineata* is a fairly common species in the southern portions of the Great Basin. The single specimen contained in the collections made at the test site is elongate, subcylindrical, color black with dense gray pubescence. Rostrum three-fourths as long as pronotum, with median, impunctate polished area. Antennae black, scape reaching eye, first segment of funicle longer than second; club elongate, oval, feebly pubescent Head clothed with white pubescence, sparsely intermixed with dark brown setae; punctate. Eyes with many facets, round. Pronotum slightly arcuate at middle, with pronounced median carina; densely punctate; from each puncture issues many branched setae (palmate); scutellum prominent, densely covered with very fine, white setae. Elytra with glabrous prominent intervals; dense pubescence on intervening intervals, surface slightly punctate, sides practically parallel. Legs and venter densely clothed with white setae; each femora with small acute tooth; claws toothed. Length 12.3 mm, width 3 mm.

Plant relationship. One specimen was collected in a Larrea community, Area 5, in October, 1961.

Subfamily Magdalinae
Tribe Magdalini

References. Germar, 1817:340; Horn, 1873: 407-469; Fall, 1913:27.

Morphological characteristics. Species of this tribe and genus have anterior coxae contiguous; elytra unicolorous, usually black, glabrous and widened posteriorly; claws simple or toothed.

Magdalis lecontei tenebrosa Fall
Fig. 10

Reference. Fall, 1913:28.

Morphological characteristics. *Magdalis lecontei tenebrosa* Fall is black throughout; femora toothed, not impressed at base; hind angles of thorax more or less produced and divergent. Antennal club normal, second funicular segment twice as long as wide, and as long as two following. Length 2.5 to 5 mm, width 2 to 3 mm.

Fig. 10. *Magdalis lecontei tenebrosa*

Plant relationships. Eleven specimens were collected in 1964 and 1965 as follows: nine in June and one in July from *Pinus monophylla*, Area 12; one from a Pinyon-Juniper community, Area 12, in July.

Subfamily Anthonominae

This is a large subfamily according to Kissinger (1964), consisting of two tribes, *Endaeini* with eleven genera and *Anthonomini* with fourteen.

The following characters will aid in placing species in this subfamily collected at the Nevada Test Site: trochanter short and triangular, femur attached to side of trochanter, base of femur closely adjacent to coxa; antennae distinctly elbowed, funiculus consisting of five to eight segments; scape fitting into scrobe; usually inserted toward apex of rostrum; club elongate, oval, entirely pubescent, distinctly annulate; rostrum not received into prosternal emargination, slender, usually longer than prothorax, mandibles small, lacking deciduous cusp; tarsus with four distinct segments, segment 3 usually strongly bilobed; mesepimeron not ascending and not visible in dorsal view; front coxae contiguous; claws free at base and with basal tooth; hind tibiae mucronate at tip; mesepimeron not ascending and not visible in dorsal view; suture between sterna 2 and 3 deep and straight.

Tribe Anthonomini

The characteristics for the tribe Anthonomini are, in the main, the same as for the subfamily Anthonominae. Thus, if a specimen agrees with the above assemblage of characters, it may well be considered as belonging to the tribe Anthonomini.

The species from the test site which belong to this tribe represent four genera which may be separated by the following key:

1. Claws toothed 2

   Claws simple. Hind tibiae mucronate; prosternum short in front of coxae. Form convex; tibial armature very evident 3

2. Posterior tibiae unguiculate; pygidium covered; claws armed with a long tooth; beak rather short and stout; eyes placed latero-inferiorly, somewhat approximate beneath ..... *Macrorhoptus* LeConte

   Posterior tibiae mucronate; scrobes long, directed against the eye; funicle of antennae 6 or 7 jointed; claws elongate, ovoidal ..... *Anthonomus* Germar

3. Scrobes directed against the eye ..... *Epimechus* Dietz

Scrobes broad and deep for about one-half the distance toward the eyes, then gradually evanescent ..... *Brachyogmus* Linell

Genus *Macrorhoptus* LeConte

Reference. LeConte, 1876:208.

Morphological characteristics. Specimens of the genus *Macrorhoptus* have the following characteristics: claws toothed; middle coxae separated; posterior tibiae unguiculate; pygidium covered; rostrum rather short and stout; eyes latero-inferior, somewhat approximate beneath.

With the aid of the key prepared by Sleeper (1957:71) the species of this genus may be separated.

KEY TO THE KNOWN SPECIES OF *Macrorhoptus*

1. Scaly vestiture on elytra without intermixed erect or semierect clavate bristles 2

   Scaly vestiture on elytra with intermixed erect or semierect clavate bristles 3

2. Scales on rostrum more or less prostrate, broadly oval, those on "ocular lobes" broadly oval; Texas and California ..... *estriatus* LeConte

   Scales on rostrum erect, elongate and narrowly clavate, those of "ocular lobes" elongate, narrowly clavate; British Columbia ..... *sidalceae* Sleeper

3. Prostrate scales on disc of elytra longitudinally striate, for the most part 4

   Prostrate scales of disc of elytra not striate at all; smaller and paler species; Texas ..... *sphaeralciae* Pierce

4. Scales of elytra prostrate, having a smoothly, evenly placed appearance; rostrum of female short and stout; Arizona ..... *hispidus* Dietz

   Scales of elytra very grizzled, being roughened in appearance; rostrum of female elongate and cylindrical; California ..... *griseus* Sleeper

Macrorhoptus hispidus Dietz

Reference. Dietz, 1891:185.

Morphological characteristics. *Macrorhoptus hispidus* has pale gray or brownish scales which are longer and broader than in *estriatus*. Prothorax densely and finely punctured, with broad stripe of pale brown scales along middle; sides paler. Legs moderately long; femora slightly clavate, anterior armed with triangular tooth, middle and posterior mutic. Tarsi moderately stout, posterior more slender, third segment bilobed. Claws armed with tooth. Length 2.4 to 3.3 mm.

Plant relationships. Ten specimens were collected during 1965 as follows: one from *Sphaeralcea* sp., Cane Springs, in June; two from *Sphaeralcea* sp., Area 17, in June; three from *Sphaeralcea* sp., Area 26, in June; one from *Grayia spinosa*, Area 18, in July; and three from *Artemisia* sp., Area 18, in July.

Comments. It is difficult to separate *M. hispidus* and *M. sphaeralciae*. The specimens before me representing the three species as above probably would be considered as two valid species with *sphaeralciae* as a subspecies of *hispidus*.

Genus *Anthonomus* Germar

Reference. Germar, 1821:320.

Morphological characteristics. Rostrum usually long and slender; scrobes long, directed against the eyes; antennal scape reaching the eye or nearly so; funicle 6 or 7 jointed; club elongate-ovate; elytra distinctly striate and punctured; pygidium in the male more or less exposed, femora usually toothed; front and middle tibiae with a hook, hind ones with a spine at tip; claws toothed.

KEY TO THE SUBGENERA OF *Anthonomus* AT THE NEVADA TEST SITE
(After Dietz, 1891:189)

1. Posterior tibiae alike in both sexes 2

   Posterior tibiae of male curved ..... *Cnemocyllus*

2. Eyes small, subrostral ..... *Anthonomorphus*

   Eyes at least moderately large, position normal. Vestiture of derm not intermixed with erect setae. Prosternum not emarginate in front, last segment of funicle distinct from the club. Club elliptic or ovoidal, not very loosly articulate ..... *Anthonomus*

Dietz divided the subgenus *Anthonomus* into nine groups. *Anthonomus bolteri confusus* belongs in the Suturalis group, *A. histus* the Squamosus group, and the species described by Fall and *ornatulus* of Dietz in the subgenus *Cnemocyllus*.

Subgenus *Anthonomorphus*

Anthonomus peninsularis Dietz

Reference. Dietz, 1891:195.

Morphological characteristics. Oblong oval, color variable, black to reddish brown; clothed with white pubescence above and beneath; rostrum slender, with striae well developed; antennae inserted about two-fifths from apex; second segment of funicle longer than third. Eyes round. Head constricted behind eyes; coarsely punctate, sparsely subescent; frontal fovea deep. Prothorax much wider than long, twice as wide at base as at apex; surface coarsely punctate, each puncture bearing decumbent white seta; more closely placed at base and median line. Elytra wider at base than prothorax, striae prominent with deep punctures; interspaces slightly convex and lightly punctate; surface white pubescence. Legs slender; femora bidentate; tarsi with bifid claws, tooth long. Length 5 to 5.5 mm, width 2.6 to 3 mm.

Plant relationships. Seven specimens were collected in 1962 and 1965 (Table 7).

Table 7. Collection records of *Anthonomus peninsularis* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
4	Mixed	April 1
17	°*Sphaeralcea* sp.	June 2
18	°*Sphaeralcea* sp.	June 1
26	°*Sphaeralcea* sp.	June 1
	°*Ephedra nevadensis*	June 1
28	°*Sphaeralcea grossulariaefolia*	May 1

Subgenus *Anthonomus*
Group Suturalis

Anthonomus haematopus confusus Dietz

Reference. Dietz, 1891:209.

Morphological characteristics. *Anthonomus confusus* is now considered to be a subspecies of *A. haematopus* Boheman. It is similar in form to *A. bolteri* Dietz, the tribe of which was described from specimens from New Mexico. It is little smaller, rufo-testaceous, with coarse conspicuous white pubescence. Rostrum stout and slightly curved; coarsely punctured. Antennae stout, second segment of funicle longer than third. Club elongate and blackish in color. Eyes slightly convex. Head with coarse punctures and frontal fovea. Prothorax constricted at apex, punctate, with coarse pubescence; elytra with deep strial punctures; pubescence short and sparse. Length 2.5 mm, width 1.5 mm.

Plant relationships. Six specimens were taken from *Juniperus* sp., and one from *Artemisia tridentata*, all in Area 16 in July, 1962.

Subgenus *Anthonomus*
Group Squamosus

Anthonomus hirtus LeConte

References. LeConte, 1876:203; Dietz, 1891: 233.

Morphological characteristics. Similar in form and sculpture to *A. murinus* Dietz; densely covered with grayish and ochreous scales; body, antennae, and legs rufoferruginous. Rostrum slender and scarcely striate or punctured; second segment of funicle practically same length as third one. Three thoracic vittae, and along suture paler, legs rufopiceous, femora not strongly clavate, anterior armed with small tooth, middle and posterior mutic; tarsi rufus. Length 3 to 3.2 mm, width 1.3 mm.

Plant relationships. Three specimens were taken in June and August, 1965, as follows: one from *Sphaeralcea* sp., Area 12; one from *Eriogonum umbellatum*, Area 16; and one from *Artemisia tridentata*, Area 19.

Subgenus *Cnemocyllus*

Anthonomus ornatulus Dietz

Reference. Dietz, 1891:241.

Morphological characteristics. Elongate subovate, piceous, antennae and legs reddish, densely clothed with broadly oval scales, white and brown on upper surface and white beneath. Rostrum long, punctured with distinct median carina. Antennae slender, club dark. Eyes more convex. Head short, punctures deep, fovea obsolete. Prothorax wider than long. Punctures deep, surface covered with scales. Elytra oval, punctures concealed by white and some brownish scales, interspaces slightly convex; legs slender, clothed with white scales; anterior femur with scarcely perceptible tooth; tarsi slender and as long as tibiae; first segment longer than second in male, or equal to it in female; last segment long, distal end and claws blackish, latter armed with short obtuse tooth. Length 2.9 mm, width 1.1 mm.

Plant relationship. One specimen was taken from *Eurotia lanata*, Area 16, in June, 1965.

Subgenus *Cnemocyllus*

Anthonomus sphaeralciae Fall

Reference. Fall, 1913:55.

Morphological characteristics. Elongate oblong, piceous; rostrum, antennae and legs rufus; vestiture dense both above and below, consisting of pale ochreo-cinereous scales which are about twice as long as wide, almost uniform in color above except along median line and at sides of prothorax where they are whitish. Scutellum densely white. Body beneath covered with whitish scales; antennal funicle seven-segmented, second joint nearly twice as long as wide. Prothorax nearly as long as wide, subconical, apical constriction feeble. Front femora with small pointed tooth, middle and hind femora mutic. Length 3.2 to 3.4 mm, width 2 mm.

Plant relationships. Seventeen specimens were collected in 1965 (Table 8).

Table 8. Collection records of *Anthonomus sphaeralciae* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
12	°*Sallugia paradoxa*	June 1
	°*Chrysothamnus viscidiflorus*	Aug. 1
	°*Sphaeralcea* sp.	Aug. 3
	°*Elymus cinereus*	Aug. 1
	°*Atriplex canescens*	Aug. 1
16	°*Sphaeralcea* sp.	Aug. 3
17	°*Tetradymia glabrata*	July 2
18	°*Oenothera californica*	June 1
	°*Artemisia* sp.	July 1
19	°*Artemisia tridentata*	June 1
23	Mixed	Aug. 1
28	°*Sphaeralcea* sp.	June 1

Subgenus *Cnemocyllus*

Anthonomus cycliferus Fall

Reference. Fall, 1913:56.

Morphological characteristics. Form oval, piceous, legs and antennae rufus, club fuscous; clothed with overlapping oval or nearly circular white scales, intermixed with scattered darker scales varying from pale brown to blackish purple in color; these darker scales aggregated most noticeably in two imperfect discal pronotal vittae and in elongate discal elytra spot at about postepinotal vittae and in elongate discal elytral spot at about posterior third, and less evidently in sub-basal spot on either side of suture. Rostrum one-fourth longer than prothorax, finely punctate, polished; origin of antennae at point two-fifths from apex in male, just beyond middle in female; prothorax three-fourths as long as wide, sides arcuate and subparallel in basal half; surface completely concealed by vestiture. Elytra at base little wider than thorax, widest about middle, striae invisible. Front femora with small tooth; middle and hind femora not visibly toothed. Ungual teeth short and not approximate at tip. Length 2.7 to 2.8 mm, width 1.1 mm.

Plant relationships. Four specimens were taken in June and August, 1965, as follows: one from *Chrysothamnus teretifolius*, Area 6; two from *Artemisia tridentata*, Areas 12 and 17; and one from *Chaenactis stevioides*, Cane Springs.

Subgenus *Cnemocyllus*

Anthonomus tennis Fall

Reference. Fall, 1913:57.

Morphological characteristics. Narrowly oval, piceous, scape and tarsi fusco-testaceous, club

fuscous; vestiture white throughout, scales circular, not dense or overlapping. Prothorax about three-fourths as long as wide; sides arcuate; elytra at base wider than prothorax; striae visible; femora without tooth. Tarsal claws with long teeth, approximate at tip. This species is closely related to *A. cyclifcrus*, but is much smaller. Length 1.3 to 1.4 mm, width 0.9 to 1.0 mm.

Plant relationships. Nine specimens were taken from 1960 to 1964 (Table 9).

Table 9. Collection records of *Anthonomus tenuis* at the Nevada Test Site.

Area	Plant Host° or Community	Month and Number of Specimens
6	Grayia-Lycium	Aug. 1
12	°*Chrysothamnus paniculatus*	Aug. 2
16	°*Artemisia tridentata*	July 3
	°*Juniperus* sp.	July 1
26	Larrea	July 1
Cane Springs	Mixed	July 1

Epimechus gracilis Fall

Reference. Fall, 1913:59.

Morphological characteristics. Form narrow and elongate, black; antennae, except club, legs and sometimes rostrum rufous; vestiture consisting of large, round, white overlapping scales. Rostrum longer than other specimens of this species before me, squamose at base, finely punctate. Antennae inserted near middle of rostrum; funicle six-segmented; first and second combined, as long as other four segments; prothorax wider than long, widest at about middle, apical constriction broad, surface coarsely punctate. Elytra twice as long as wide, and three times as long as prothorax; striae strongly punctured. Femora mutic; claws simple. Length 1.6 to 1.9 mm, width 0.70 to 0.80 mm.

Plant relationship. Four specimens were taken from *Chrsothamnus viscidiflorus*, Areas 12 and 17, in August, 1965.

Genus *Brachyogmus* Linell

Reference. Linell, 1897:51.

Morphological characteristics. Type of the genus *Brachyogmus* is a small species; length 2.9 to 3.1 mm, width 1.3 mm; form convex; prothorax narrow; rostrum longer than head and prothorax; antennal scrobes straight, directed against the eyes, but abbreviated long before reaching them; hind tibiae mucronate; prosternum short in front of the coxae; claws simple, divergent.

This genus is closely related to *Epimechus* from which it differs in the narrow prothorax and the gradually evanescent scrobes.

Brachyogmus ornatus Linell

Reference. Linell, 1897:51.

Morphological characteristics. Form subovate, piceous, body color concealed by rounded scales, variegated with white, black and ferruginous, broad blackish variable band across elytra at about the middle. Rostrum longer than head and prothorax, at base scaly with white and ferruginous, outwardly shining piceous. Scrobes commencing two-fifths from apex, deep for about one-half distance toward eye, then gradually evanescent. Scape of antennae reaching eye, clavate at apex; funicle as long as scape, seven-segmented, each segment bearing whorl of long white hairs. Eyes round, front between eyes depressed and covered with ferruginous scales. Prothorax as broad as long, sides rounded, disc covered with white and ferruginous scales which are variable in pattern; some with white median line bordered with dark bands. Scutellum conspicuous, with dense white setae. Elytra at base much wider than prothorax; twice as long as broad; striae deeply impressed, punctures concealed; intervals slightly convex, suture elevated toward apex; broad band across suture at middle with numerous spots on other areas; scales white, blackish to ferruginous. Ventral scales white, mixed with ferruginous ones. Femora clavate, toothed; tibiae mucronate at apex; tarsi piceous, clothed with white setae; first two segments equal, third emarginate, slightly wider; claws strong, black. Length 2.9 to 3.1 mm, width 1.3 mm.

Plant relationships. Two specimens were taken in April, 1961; ten in July, 1960; and one in July, 1962, all from *Lycium pallidum* in Area 5.

Subfamily Tychiinae

Tribe Tychiini

Genus *Tychius* Germar

Reference. Germar, 1817:340.

Morphological characteristics. The genus *Tychius* has the following distinctive characteristics: body elongate-oval, with robust recurved setae; eyes large, very nearly circular; head dorsally not constricted behind eyes; antennal

funicle with six segments. Casey divided this genus into four subgeneric groups; *T. prolixus* is the only one placed in the third subgenus which is said to have but six segments in the antennal funicle.

Tychius prolixus Casey

References. Casey, 1892:419; Kissinger, 1964: 57.

Morphological characteristics. *Tychius prolixus* is a blackish, oblong-elongate, convex form; tip of rostrum and antennae pale reddish; vestiture dense, consisting of long, slender subrecumbent squamules on pronotum, pale fulvous in color but whitish along middle and sides; on elytra scales large, dense, rounded, imbricated with some reddish-gray in color; each interval with single series of coarse, recurved, reddish pointed setae. Head with large circular eyes; beak with prominent tuft above each eye; glabrous and shining beyond antennae, equal in length to prothorax. Prothorax wider than long; sides feebly arcuate from base nearly to apex, then rather abruptly constricted. Elytra wider than prothorax and not quite three times as long; sides parallel and straight in basal two-thirds; apex obtuse; depression at declivity. Legs and under-surface clothed with whitish scales. Length 3.3 mm, width 2 mm.

Plant relationship. One beetle was taken from *Astragalus lentiginosus*, Area 17, in June, 1965.

Subfamily Cryptorhynchinae
Tribe Cryptorhynchini

Genus *Zascelis* LeConte

Reference. LeConte, 1876:256-258.

Morphological characteristics. The genus *Zascelis* in the United States is confined to lower California and the southwestern United States. The species are elongate, depressed, coarsely sculptured, pubescent and sometimes scaly. Rostrum long, slender, and extends almost to metasternum. Antennae vary with species. Ventral sutures deep, first one slightly sinuate; first ventral segment longer than second which is equal to third; fourth and fifth equal in length. Mesosternum elongate and deeply excavated almost to base. Femora armed beneath with small tooth; tibia broad, compressed, with row of teeth along anterior margin which is variable in species.

The following is a key to the species of *Zascelis*:

1. Pubescence long, not mixed with scales 2
   Pubescence shorter; tibiae feebly toothed. 3
2. Tibiae very coarsely toothed; length 7 mm ..... *serripes* LeConte
   Tibiae very finely and sparsely toothed; length 4 to 4.8 mm ..... *oblonga* Horn
3. Pubescence short, erect, intermixed with large scales ..... *squamigera* LeConte
   Pubescence prostrate, squastriform and collected in spots on the elytra ..... *irrorata* LeConte

Zascelis irrorata LeConte

Reference. LeConte, 1876:257.

Morphological characteristics. Elongate, black, pubescence fine, short, sparse, prostrate, subsquamiform, and collected in spots on elytra. Rostrum and head densely punctured. Prothorax as wide as long, sides parallel behind, slightly constricted at tip, coarsely punctured, with narrow, smooth dorsal line. Elytra little wider than prothorax, striae composed of large approximate punctures, interspaces narrow, punctured. Femora with small tooth; tibiae feebly serrate, dentate near tip. Ventral surface coarsely punctured; each puncture supports pale, scale-like hair. Length 5.0 to 6.6 mm, width 2.5 to 3 mm.

Plant relationships. Specimens taken are as follows: six in a Pinyon-Juniper community in Area 12: one in August, 1965, and five in July, 1962; and one in a Grayia-Lycium community, Area 1, in August, 1961.

Subfamily Ceutorhynchinae
Tribe Ceutorhynchini

Genus *Ceutorhynchus* Germar

Reference. Germar, 1824:217.

Morphological characteristics. The major characteristics of the genus *Ceutorhynchus* are:

tarsi with two claws; pygidium not excavated but carinate in front with transverse line for reception of tips of elytra; pectoral groove not extending behind front coxae, sometimes wanting, second ventral never prolonged; rostrum longer and slender, usually half length of body; eyes wholly or partially concealed by post-ocular lobes; mesosternum oblique, not sulcate; middle coxal cavities closed within; sternites 3 to 5 unequal; third tarsal segment bilobed.

Ceutorhynchus adjunctus Dietz

Reference. Dietz, 1896:436.

Morphological characteristics. The species *Ceutorhynchus adjunctus* Dietz found in Nevada, Utah, and western Colorado may be separated from *C. horni* Dietz and *C. nodipennis* Dietz to which it is closely related as follows: similar in form, density of scaly covering; size; but different in having paler scales; legs rufotestaceous; elytral interspaces alternately wider, elytral tubercles confined, in the main, to humeral region and summit of declivity; several small tubercles near base of sixth interval; some specimens have small black tubercles on third, fifth, and sixth interval; each tubercle has white, straight seta issuing from its center and point posteriorly; prothorax with prominent cluster of two or three tubercles on lateral margin just back of deep, apical constriction. First segment of funicle twice as long as second, slender and bulbous at distal end, segments 2 to 7 slender; club large, ovoidal acuminate. Legs long, slender, tibiae unguiculate, third segment of tarsi broadly bilobed; claws bifid. Last ventral segment foveate. Length 1.8 to 2 mm; width 1.0 to 1.3 mm.

Plant relationship. All specimens were taken in 1965 from *Stanleya pinnata*—six in Area 12 in August, and two near Cane Springs in June.

Ceutorhynchus tescorum Fall

Reference. Fall, 1907:270.

Morphological characteristics. Body piceous, oval, legs rufous throughout; upper surface clothed with short piliform scales which are yellowish-white in color. Pale scales condensed in pronotal channel and along elytral apices; elongate sutural spot of dense white scales on sutural interval only and about one-fourth length of suture. Under-surface with whitish oval scales; rostrum feebly substriate at base; antennae inserted at middle, funicle six-jointed. Head with pale yellow piliform scales, occiput carinate. Prothorax one-third wider than long, strongly convergent anteriorly, apical constriction moderate, apical margin feebly elevated; pale line in median channel. Elytra wider than prothorax. Striae not deep, intervals nearly flat, vestiture mottled on disc, few dark scales at apex. Femora not toothed; claws with very small basal tooth. Length 2.6 mm, width 1.6 mm.

Plant relationship. One specimen was taken from *Argemone corymbosa*, Area 16, date unknown.

Comments. Fall pointed out that this species may be readily identified due to its six-segmented funicle, simple femora, and toothed claws which form a combination that excludes it from all of the groups indicated by Dietz. It may be placed between the *squamatus* and *septentrionis* groups of that author.

Subfamily Baridinae
Tribe Madarini

Genus *Onychobaris* LeConte

Reference. LeConte, 1876:294.

Morphological characteristics. LeConte characterized the genus *Onychobaris* as containing those species in which the club of the antenna is more oval, entirely sensitive and pubescent, first segment forming less than one-half the mass; second segment of funicle not longer than third; and claws divergent and larger than usual.

In other respects this genus agrees with *Baris* Germar, and the species may be classified similarly, although the front coxae are usually much more widely separated than in *Baris*.

Onychobaris mystica Casey

Reference. Casey, 1892:531.

Morphological characteristics. *Onychobaris mystica* is oblong-oval, convex, densely sculptured, piceous-black; head, rostrum and legs rufus; setae short and sparse. Head punctate toward apex, transverse groove distinctly impressed, polished, impunctate, rostrum especially so at sides, median impunctate line distinct and entire; antenna with second funicular segment rather long, scarcely twice as long as wide but subequal to next two. Prothorax one-fourth wider than long, sides subparallel in basal three-fourths, then strongly rounded and convergent to apex, truncate and distinctly constricted at sides; base subtransverse, median lobe large, prominent, broadly rounded, disc without trace of median line; punctures coarse, evenly placed. Scutellum small. Elytra little longer than wide;

disc with abrupt, deep, coarse and confusedly punctured grooves, intervals flat, narrow, and subequal. Abdomen coarsely and densely punctured. Length 3.7 to 4 mm, width 1.9 to 2.1 mm.

Plant relationship. Seven specimens were taken from *Opuntia acanthacarpa*, Area 5, in June, 1965.

Onychobaris near *depressa* Casey

Reference. Casey, 1892:525-526.

Morphological characteristics. Form oblong-oval; black; legs rufo-piceous; setae short decumbent, whitish, and not abundant. Head finely, densely punctured; impression of rostrum down to origin of scrobes, which are deep and directed below eye. Prothorax wider than long, apex slightly constricted, base transverse, median lobe well developed; no depression of median basal lobe; disc convex, densely punctate; setae short, no median carina; scutellum very small. Elytra longer than wide; disc with fine, not very deep but abrupt striae, intervals with two rows of short, decumbent white setae, row of setae in each stria; punctures dense, not deep. Abdomen and legs densely covered with fine punctures and setae.

Plant relationships. Seven specimens were collected during 1964 and 1965 (Table 10).

Table 10. Collection records of *Onychobaris* near *depressa* at the Nevada Test Site.

Area	Plant Host	Month and Number of Specimens
5	*Stanleya pinnata*	July 1
6	*Chrysothamnus teretifolius*	July 1
16	*Argemone corymbosa*	June 1
17	*Franseria acanthicarpa*	Aug. 1
Cane Springs	*Asclepias erosa*	June 3

Subfamily Rhynchophorinae
Tribe Sipalini

Genus *Yuccaborus* LeConte

References. LeConte, 1876:333-334; Casey, 1892:687-689, 1904:312-324.

Morphological characteristics. *Yuccaborus* is a distinctive genus with an elongate, glabrous body; rostrum straight, as long as prothorax, sculptured beneath with three longitudinal grooves; scrobes short, eyes transverse, contiguous beneath, widely distant above, not extending to upper surface of head. Antennal scape reaching eyes; funicle six-segmented, seventh forms corneous shield on basal part of club. Prothorax longer than wide, slightly narrower at tip than at base, constricted. Scutellum, small, rounded. Elytra with shallow punctured striae, intervals wider, sparsely punctured; rounded at tip, pygidium slightly exposed. Legs slender, femora not clavate, tibiae feebly serrate on inner side, especially front pair; inner angle unguiculate; tarsi slender, third segment bilobed, not spongy beneath, but smooth and glabrous like others.

The outstanding characters of this genus are: eyes contiguous beneath and widely separated above; antennal club is corneous sheath; small third tarsal segment not spongy beneath.

Casey (1892) described three species and proposed the following key which may be used to separate them from *Y. frontalis*. I have added *lentiginosus* Csy. (1904) to the key:

1. Piceous-brown, punctation of the upper surface finer and more remote 2

   Black, much larger, coarsely and deeply sculptured; legs and tarsi stouter ..... *grossus* Csy.

   Black, smaller, finer and less deeply punctured; many of the punctures surrounded by pale yellowish-white spots, legs moderate, shining, finely punctate ..... *lentiginosus* Csy.

2. Body narrowly cylindrical, the elytra more than twice as long as wide; punctures of the elytral series becoming very fine and feeble in apical half as usual; fifth and sixth series coalescent at base; humeri tumid and prominent ..... *frontalis* Lec.

   Body much more robust, the elytra not quite twice as long as wide; punctures of the elytral series deep throughout, although small in apical half as usual; fifth and sixth series widely separated at base; humeri not tumid ..... *sharpi* Csy.

I have studied specimens of this genus from Arizona, Nevada, and California, and agree with Sleeper (1960) that Casey's *Y. grossus* is a valid species. The Nevada and Arizona specimens fit LeConte's description of *Y. frontalis*. *Yuccaborus sharpi* Casey is a Mexican species. *Yuccaborus lentiginosus* specimens, due to the "elytra dull and with many of the punctures of the intervals surrounded by a pale yellowish-white modification of the surface, the punctures along each side of the pronotum also so affected," smaller in size, with finer sculpturing and elytra only a fourth wider than the prothorax separates it as a species, in my opinion, from *Y. grossus*.

Anderson (1948) reports that Barber considered the galleries of *Y. lentiginosus* similar to *Dendroctonus*. On the basis of the larvae, Boving and Craighead (1931) were able to separate the Curculionidae and Scolytidae. Crowson (1955) includes the Scolytidae and Platypodidae in the family Curculionidae.

Yuccaborus frontalis (LeConte)

Reference. LeConte, 1874:70.

Morphological characteristics. Body black, shining; head sparsely, coarsely punctured, rostrum straight, as long as prothorax, coarsely and densely punctured, sulcate and sparsely setose each side; frontal fovea distinct. Eyes contiguous beneath, widely separated above; prothorax longer than wide; apex tubularly constricted, disc coarsely but not densely punctured. Elytra with rounded humeri, sides parallel, striae finely punctured, intervals flat, with few small punctures; lateral margins and under-surface of prothorax densely and coarsely punctured. Legs slender, front tibiae with several small teeth on inner edge. Length 12.5 to 14.2 mm, width 4.9 to 5.5 mm.

Plant relationship. Five specimens were collected in a mixed community, Area 23, in August of 1961, 1964, and 1965.

NOTES ON THE BIOLOGY OF SOME NEVADA TEST SITE WEEVILS

The life histories and host plants of the weevils of the Great Basin are poorly known. In this study an attempt was made to bring together information on the biologies of the weevils of this report. Many of the species dealt with are represented by one or not more than three or four specimens. This, no doubt, is due to lack of intensive collecting, such as beating and sweeping of the shrubs and smaller plants. The apterous species found on *Atriplex*, *Coleogyne*, *Grayia*, *Larrea*, *Kochia*, *Lycium*, *Franseria* and other shrubs of the area are not easily collected by traps or lights. They are taken mainly by beating or close examination of the plants and by hand picking.

I have searched the literature to find the recorded host plants of the species discussed in this study but have met with little success. What information I have gleaned from the literature or the field notes taken at the Nevada Test Site are presented here.

Species of *Trigonorhinus* (*Brachytarsus*) were reported by Blatchley and Leng (1916) as breeding in stored corn, peas, and cowpeas; stems of wide rye and in the smut of corn and wheat; also taken on ragweed, *Ambrosia artemisiaefolia*, and from the pod of the bladdernut, *Staphylea trifolia*. According to Valentine (1960), "*Trigonorhinus* species are plant feeders like the majority of the family, but the generically distinct Old World species of *Anthribus* Foster, 1771 (formerly *Brachytarsus* Schoenherr, 1823), have larvae which are predaceous on the eggs of certain lecaniine scale insects." The specimen collected at Mercury was on burr-sage, *Franseria acanthicarpa*.

No reports of plant association for the species *Thinoxenus nevadensis* and *Thricolepis inornata* have been found in the literature. At the Nevada Test Site *T. nevadensis* was taken in a Pinyon-Juniper Community, but the specific host plant is unknown. *Thinoxenus inornata* was taken on Gamble oak at the test site; it is common on oaks in Utah. The *Eucyllus* species at the test site are wide-spread in most of the communities. One specimen was taken on winter-fat, *Eurotia lanata*. I have not found any reference to the host plants for this genus. *Aragnomus hispidulus* specimens were taken on *Coleogyne*, *Grayia*, and *Larrea* plants. No other references to plant hosts for this species have been found. Van Dyke reported collecting *Aragnomus setosus* by beating manzanita.

The *Cryptolepidus* species are typical of this xerophytic region. Some of the species such as *C. leechi*, *C. planifrons*, and *C. rugicollis* were reported by Ting (1940) as living on *Atriplex* and *Sarcobatus vermiculatus*. At the test site *C. leechi*, *C. nevadicus*, *C. aridus*, and *C. cazieri* were taken in *Atriplex* associations. One speci-

men of *C. nevadicus* was taken on evening primrose, *Oenothera californica.*

Other short-nosed weevils of the genera *Ophryastes, Orimodema, Paracimbocera, Miloderus,* and *Dirotognathus* are closely associated with the desert flora of the Great Basin. Fall, Van Dyke, Casey, Horn, and Davis, however, did not record plant hosts for this complex. Ting (1940) collected the holotype female of *P. artemisiae* on *Artemisia* sp. *Ophryastes varius* and *O. geminatus* are common species on *Larrea divaricata* and *Atriplex canescens* in the test site area as well as areas of the Great Basin where these plants are found. Collier, according to Ting (1940), observed *Paracimbocera artemisiae* injuring the twigs of apple trees in Grand Valley, Colorado, in April, 1911.

Orimodema protracta and *Dirotognathus sordidus* were collected in the Pinyon-Juniper community, but a definite plant host was not determined. *Miloderes mercuryensis* was collected on *Sphaeralcea ambigua* and *Grayia spinosa.*

One-half of all the specimens of weevils considered in this study are *Cleonus denticollis* which was described from a series of five specimens collected at Peach Springs, Arizona. Casey (1891) did not indicate with what plants this species may be associated. The tribe Cleonini has adults of many species associated with water plants. According to Blatchley and Leng (1916) the larvae feed upon different kinds of *Polygonum* (smartweed) and other plants such as dock, ragweed, and wild sunflower. More than a hundred specimens of *C. denticollis* were collected in the Grayia-Lycium community, and some specimens were taken on *Hymenoclea fasciculata* and *Larrea* sp. at the test site.

The host-plant records for *Smicronyx imbricatus as reported* by Anderson (1962), follow: *Gutierrezia lucida, Pluchea sericea, Chrysothamnus speciosus, Prosopus juliflora, Covillea tridentata, Pinus edulis,* and *Pinus monophyllum.* This species is common in the Mercury area, and Table 6 shows the wide variety of plants in most of the communities upon which *S. imbricatus* feeds. *Promecotarsus densus,* which is included in the subtribe Smicronychini, has similar food plant preferences to that of species of *Smicronyx,* having been collected on *Artemisia tridentata* and *Juniperus osteosperma.*

Larvae of species of the genus *Apion* were reported by Blatchley and Leng (1916) "to feed, for the most part, on seeds, principally those of legumes, though some form galls on the stems and leaves of plants, others knots on the roots, while a few bore into the pith and form a kind of cocoon of the gnawed particles." Specimens of *A. sordidum* are reported as forming galls on *Artemisia.* Specimens of *A. varicorne,* which is a wide-spread and variable species, were taken on *Dalea polyadenia* and *Eriogonum nodosum.*

Species of *Auletobius* are reported by Blatchley and Leng (1916) as occurring on sweetfern, *Comptonia perigrina,* bayberry, *Myrica cerifera,* and leather-leaf, *Chamaedaphne calyculata.* At the Nevada Test Site *A. humeralis* was collected on *Ephedra nevadensis. Auletobius* sp. was also found on *E. nevadensis* and *Chrysothamnus viscidiflorus.*

Myrmex l. lineata was collected in a *Larrea* community.

Magdalis lecontei tenebrosa was collected on *Pinus monophylla* at the test site. Buchanan (1934) described *M. piceae* from specimens reared from Colorado blue spruce, *Picea pungens glauca.* All the species of *Magdalis* breed in the bark and wood of various coniferous and deciduous trees.

All the species reported in the tribe Anthonomini in this study breed and feed in the seeds of plants. Blatchley and Leng (1916) record them as living in the buds, flowers, fruits, and seeds of plants. Some species are plant-gall formers. The larvae pupate in the feeding cell instead of entering the ground. *Macrorhoptus hispidus* was collected on *Sphaeralcea* sp., *Grayia spinosa* and *Artemisia* sp. at the test site. *Anthonomus peninsularis* was collected on *Sphaeralcea* sp. and *Ephedra nevadensis; A. haematopus confusus* occurs on *Juniperus* sp. and *Artemisia tridentata; A. ornatulus* was collected on *Eurotia lanata; A. sphaeralceae* was found on eight different plant species (Table 8); *A. cycliferus* was collected on species of *Chrysothamnus, Artemisia* and *Chaenactis; A. tenuis* occurs on five different plant species at the test site. *Epimechus gracilis* was taken from *Chrysothamnus viscidiflorus. Brachyogmus ornatus* breeds in the flowers and seeds of *Lycium pallidum* at the test site.

Tychus prolixus was collected on *Astragalus lentiginosus* at the site. *Zascelis irrorata* occurs in the Juniper and Grayia-Lycium communities. Ceutorhynchini species, both native and introduced, are found in mesophytic to hydrophytic conditions. The larvae feed on "seeds, seedstalks, or the stems of plants" (Blatchley and Leng, 1916). At the test site, *Ceutorhynchus adjunctus* was collected on *Stanleya pinnata* and on an unknown plant species near Cane Springs. *Ceutorhynchus tescorum* was collected on prickle-poppy, *Argemone corymbosa.*

The genus *Onychobaris* in the tribe Madarini is represented by two species in this report. Species of this genus are found mainly in the western dry desert regions. Fall (1913) reports that he has taken *O. densa* on "flowers of a low fleshy-leaved plant just above the beach near San Diego." Seven specimens of *O. mystica* collected in Area 5 at the test site were on *Opuntia acanthacarpa*. Specimens of *Onychobaris* sp. near *depressa* were collected on five different species of plants (Table 10).

LeConte (1874) described *Yuccaborus frontalis* from a specimen found under a bark of Yucca in the Mohave Desert. At the Nevada Test Site this species was collected in a mixed community.

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Fig. 11. Map of the areas of the Nevada Test Site

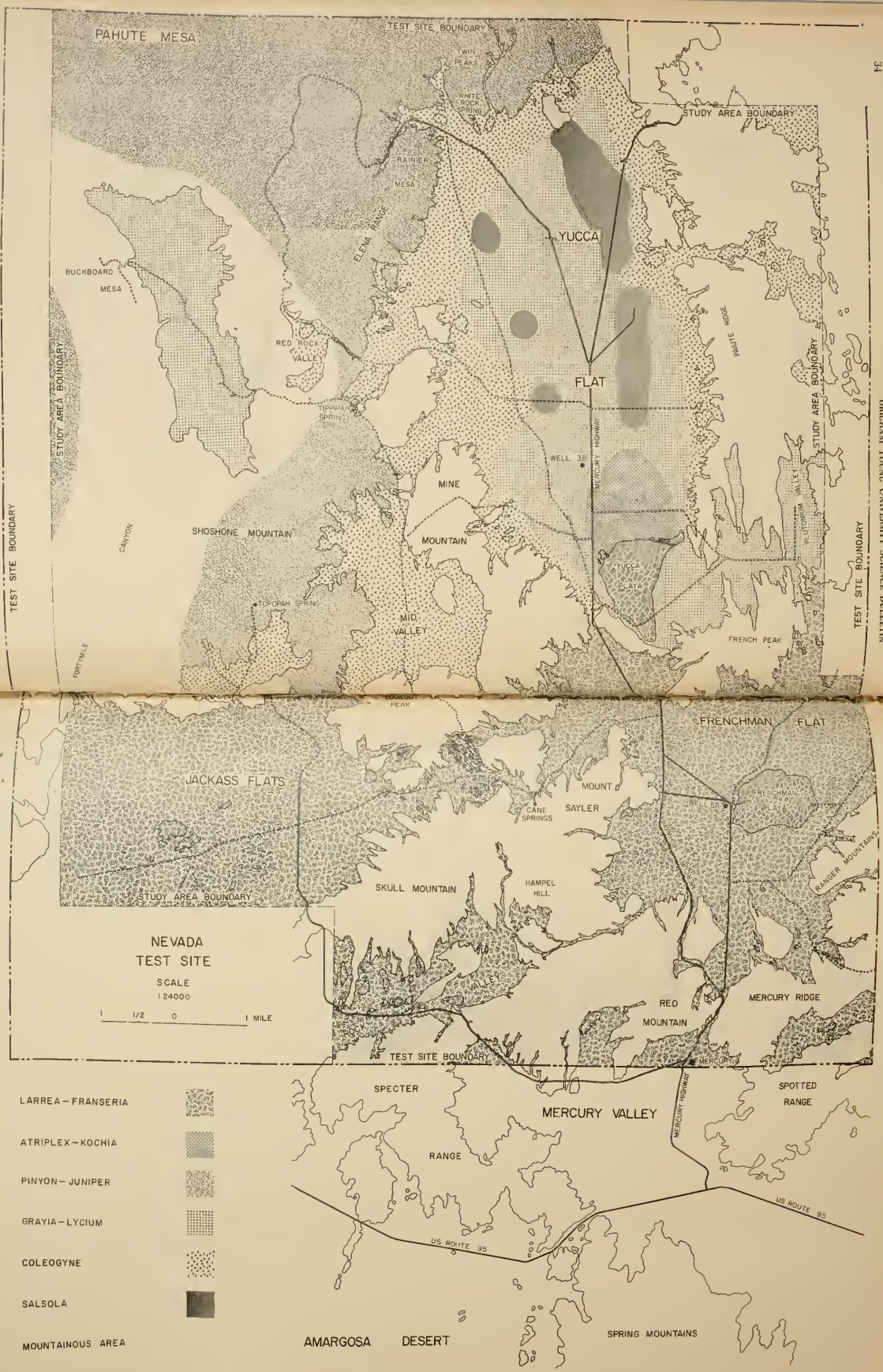

Fig. 12. Extent of the major plant communities of the Nevada Test Site

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A COMPARATIVE OSTEOLOGICAL STUDY OF TWO SPECIES OF COLUBRIDAE (*PITUOPHIS* AND *THAMNOPHIS*)

by

Robert E. Bullock[1] and Wilmer W. Tanner[2]

INTRODUCTION

Snake anatomy has been generally neglected. Although some early writers recorded observations on the anatomy of snakes, no attempt has been made to undertake a comprehensive study, and Cole (1944) has rightfully referred to this section of vertebrate anatomy as an "almost virgin field." Snakes deserve more intensive investigation because of the considerable number of adaptations demonstrated by them, their peculiar types of locomotion, and methods of feeding. It is important to comprehend their anatomical specializations if we are to understand the evolutionary trends among modern reptiles. It also is evident that comparative descriptions of serpents, thus far based mainly on external characteristics, need to be supplemented by accounts of their internal anatomy.

The purpose of this study is threefold:

(1) To work out in detail the osteology of two common members of the family Colubridae.

(2) To compare the bones and bone structures of the two species in order to determine their anatomical similarities and differences, and to use these comparisons in determining the different specializations that have been made by two common serpents.

(3) To relate the structural differences of these genera, as far as possible, to some of the other generic groups previously reported.

Our original intent was also to include the myology of the head, neck, and anterior trunk region (first 10 vertebrae). This proved to be a major effort in itself, and such a report will appear separately at a later date.

The gopher snake, *Pituophis catenifer* Blainville, and the plains garter snake, *Thamnophis radix* (Baird and Girard), were chosen for this study because of their moderately large size and relative abundance. One of them (*P. catenifer*) constricts its prey. The other (*T. radix*) swallows it alive. This difference in mode of feeding may be responsible for some structural modifications.

Although it is not the purpose of this study directly to resolve any phylogenetic or taxonomic problems, it is hoped that it will encourage other anatomical studies of reptiles, add to our present understanding of homologies, and indicate important internal phylogenetic and taxonomic structures as suggested by Robinson and Tanner (1962).

Although no previous investigator has studied the osteology of the two species included in this study, the general gross anatomy of various other snakes has been known for a long time. Ahrenfeldt (1955) stated that as far back as 1573 there were some fragmentary accounts of snake anatomy published in Europe, but Cole (1944) mentioned that it was not until 1683 that the first workmanlike and relatively accurate description of serpent anatomy was made by Edward Tyson on a "Timber Rattlesnake" said to have been collected in the West Indies.

Owen (1866) gave one of the first detailed accounts of the osteology and myology of snakes based on his work with the species *Crotalus horridus*, *Python tigris*, *Boa constrictor*, *Naja tripudians*, and *Deirodon scaber*. Although Owen's work on this section of the vertebrates is a general account by our standards, in his time it was a major contribution to this area of anatomy. Another work dealing with snake anatomy is a laboratory dissecting guide by Kellicott (1898) for the genus *Heterodon*. Unfortunately, the descriptions lack detail and are therefore somewhat superficial and in many areas incomplete.

Huxley (1871), Gegenbaur (1878), Hoffman (1890), Sedgwick (1905), Wiedersheim and Parker (1907), Williston (1925), Kingsley (1917), Goodrich (1930), and Versluys (1937) were some of the early textbook writers who

[1]Lethbridge College, Lethbridge, Alberta, Canada.

[2]Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

dealt with the subject of snake osteology. Most of these writers restricted their studies to the skull of serpents, and on occasion included one or more generalized vertebrae. Romer's "Osteology of the Reptiles" (1956) deals only briefly with serpents, but does bring some of the terminology and many of the homologies up to date.

Two volumes by Ludicke (1962, 1964) devoted entirely to the anatomy of serpents deal rather extensively with the developmental and adult anatomy of several species of snakes, including a few colubrid species. Many of the descriptions and comparisons in these works are of a general nature and, therefore, are of limited value in making comparisons with the colubrid species involved in this study.

Sood (1941, 1948) published two papers dealing with the vertebral column of serpents. The first is concerned with the caudal vertebrae of the sandsnake, *Eryx johnii* (Russell), and illustrates many unique peculiarities in its vertebral anatomy. The second study includes both minute and gross vertebral anatomy for several other Asian species.

An extensive work by Edgeworth (1935) describes and compares the development of the cranial muscles and associated skeletal structures in forms ranging from the fishes to the mammals. Haas (1930) and Cowan and Hick (1951) also dealt with the musculature of snakes, but included skeletal structures as well. Albright and Nelson (1959) dealt with the cranial osteology and the musculature of the colubrid snake *Elaphe obsoleta quadrivittata*.

Perhaps more osteology has been done with venomous species, particularly with the teeth (fangs) and skull. The work of Klauber (1956: 712-743) is a good example.

We made no major attempt here to exhaust the references which may refer to snake anatomy. Those referred to above represent some of the more important works that we have seen. We were greatly surprised when we found relatively few studies dealing with either of the two common colubrid genera *Pituophis* and *Thamnophis*.

Our prime concern, therefore, is to provide detailed descriptions and drawings which will set forth the skeletal anatomy as we found it in these genera.

MATERIALS AND METHODS

This comparative study utilized the species *Pituophis catenifer deserticola* Stejneger and *Thamnophis radix haydeni* Kennicott. The fourteen specimens of *P. c. deserticola* used were collected in Grand, Kane, Utah, San Juan, Garfield, and Uintah Counties, Utah. The twelve specimens of *T. r. haydeni* came from Warner County, Alberta, Canada. However, two specimens of *P. catenifer sayi* Schlegel from Medicine Hat, Alberta, Canada, two *T. elegans vagrans* Baird and Girard from Utah County, Utah, and four *T. sirtalis parietalis* Say from Salt Lake County, Utah, were also dissected and studied. These additional species are similar within their respective genera; therefore, a description of these is not included.

The skeletons were prepared in several different ways, depending on whether fresh or preserved snakes were used, and upon the degree of articulation required. Disarticulated skeletons were prepared from fresh material by bacterial action. The snake was skinned, eviscerated, and placed in a container with enough water to cover the specimen so as to accelerate the decomposition process. After a few days in hot weather, the macerated material was placed on a fine mesh screen and a jet of water was used to clear away the remaining tissue. Some of the bones were bleached in a 3% solution of hydrogen peroxide for ten to twelve hours.

Most of the articulated skeletons were prepared from fresh material. The fresh, skinned, and eviscerated snake was placed in a 25% solution of ammonium hydroxide for one week, then boiled for two to ten minutes until the tissues were loose but the ligaments still intact. A small jet of water was used to clear the soft tissue from the vertebral column. This jet proved to be too harsh on the more delicate and loosely connected bones of the skull. To remove the deeper skull muscles it was necessary to use forceps under a stereoscopic microscope. This latter method was essential in preparing skulls without distortion or loss of small bones.

A few snakes preserved in alcohol were utilized in the preparation of skeletal material. These were cleaned by placing them for two days in a solution of two ounces of trisodium phosphate to each quart of water. The material was then boiled in water for varying lengths of time, the time determined by the type of skeletal preparation desired. Soaking the preserved

material in concentrated ammonium hydroxide instead of trisodium phosphate before boiling proved to be almost as satisfactory.

Specimens were studied and drawings made to scale with the aid of a hand micrometer.

Literature dealing with the complete osseous skeleton of the snake is fragmentary and limited. Because the literature to date, as far as we were able to ascertain, reveals no account of the osteology of either *P. catenifer* or *T. radix*, the homologies were worked out and derived from work done by Owen (1866), Kellicott (1898), Romer (1956), Sood (1941, 1948), and the more recent works by Albright and Nelson (1959), and Ludicke (1962, 1964). The terminology for the skull structures used herein was adopted chiefly from Romer (1956), and the terminology for the vertebral column from Sood (1941, 1948).

The two snakes studied are anatomically similar; therefore, to avoid unnecessary repetition a complete description of *P. catenifer* was prepared, but *T. radix* is discussed only in connection with comparative structures that differ in the two forms. The plates were prepared with sufficient detail to aid in the comparisons of similar structures in the two species.

VERTEBRAL COLUMN

In *P. catenifer* as in other snakes, the vertebrae are numerous and procoelous, with ball and socket articulations which allow free movement. All of the vertebrae articulate with ribs except the atlas, axis, first thoracic, and caudals. The successive vertebrae not only articulate by the usual pre- and post-zygapophyses and by the procoelous centra, but also by additional articulations such as the zygosphenes and zygantra.

The division of the ophidian vertebral column into well-marked regions is less distinct than it is in other higher vertebrates. Owen (1866), Sedgwick (1905), Reynolds (1913), Williston (1925), and others considered the column to be made up of two regions—a precaudal region, and a caudal region.

Five regions were distinguished by Rochebrune (1881)—the cervical, thoracic, pelvic, sacral, and cocygeal. Although these regions can be distinguished one from another, the differences are slight and variable. Because this classification was somewhat superficial and could not be regarded as equivalent to the regions of the vertebral column of other vertebrates, it was presumably not adopted by later workers.

Sood (1941, 1948) retained the division which separated the column into two regions (precaudal and caudal), but distinguished several subregions of each as follows:

I. The Precaudal Region
   - A. **Cervical Subregion,** composed of the first two vertebrae, atlas, and axis.
   - B. **Thoracic Subregion,** consisting of all the vertebrae that follow the axis and bear prominent hypapophyses.
   - C. **Lumbar Subregion,** consisting of the vertebrae situated between the thoracic subregion and the caudal region. The hypapophyses are reduced in size or completely lacking in this area.

II. The Caudal Region
   - A. **Anterior Caudal Subregion,** situated immediately behind the precaudal vertebrae. Vertebrae are provided with both fixed and articulating bifurcated ribs called *processi costotransversii* or lymphapophyses.
   - B. **Middle Caudal Subregion,** containing fixed ribs which are unforked and differing from the posterior caudal subregion in the absence of haemapophyses.
   - C. **Posterior Caudal Subregion** comprising vertebrae with a pair of flat, platelike haemapophyses on the ventral aspect of their centra. This area shows a gradual reduction in the size and development of the vertebrae and vertebral processes from anterior to posterior until they are represented near the end of the tail by extremely short vertebrae with almost wholly vestigial processes.

Because the division of the vertebral column as outlined by Sood is in general use, the preceding vertebral classification will generally be followed; however, a few modifications have been made in order to adapt it to the species involved in this study.

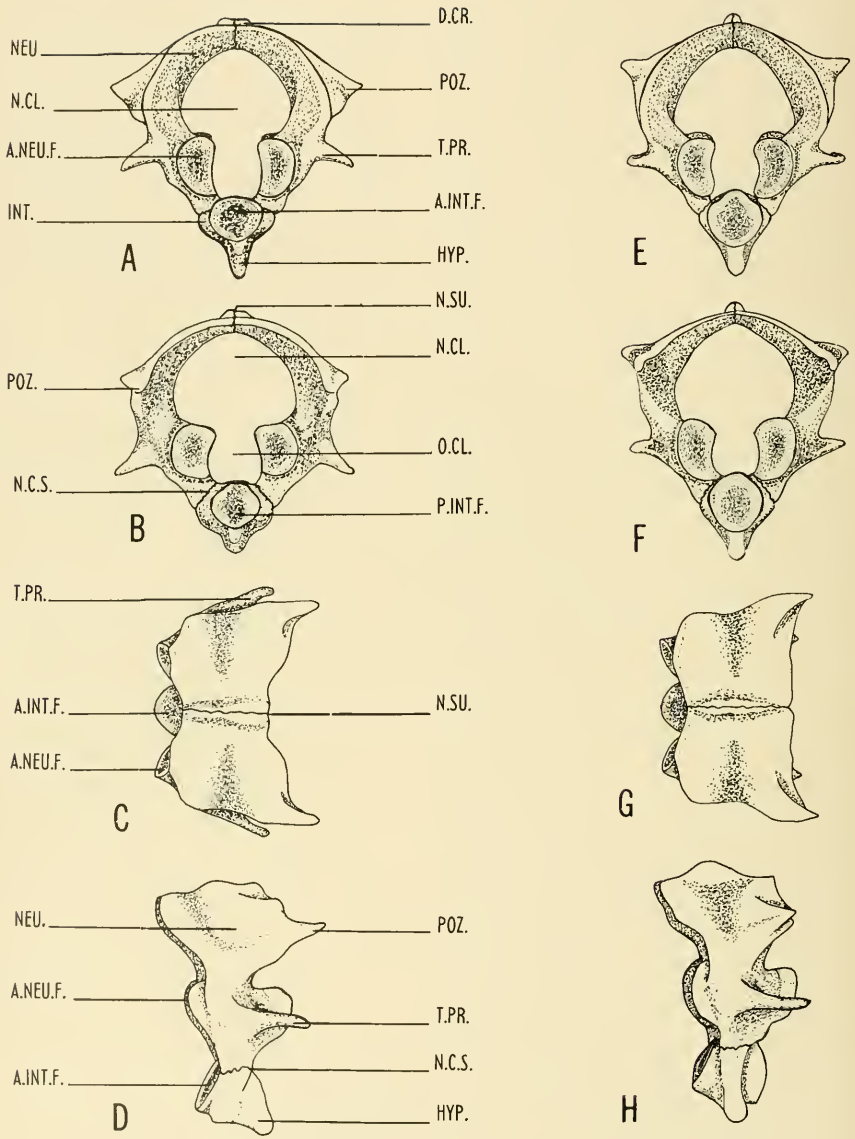

Fig. 1. Atlas. *Pituophis catenifer*, A-D, 9X: A, anterior; B, posterior; C, dorsal; D, lateral. *Thamnophis radix*, E-H, 15X: E, anterior; F, posterior; G, dorsal; H, lateral.

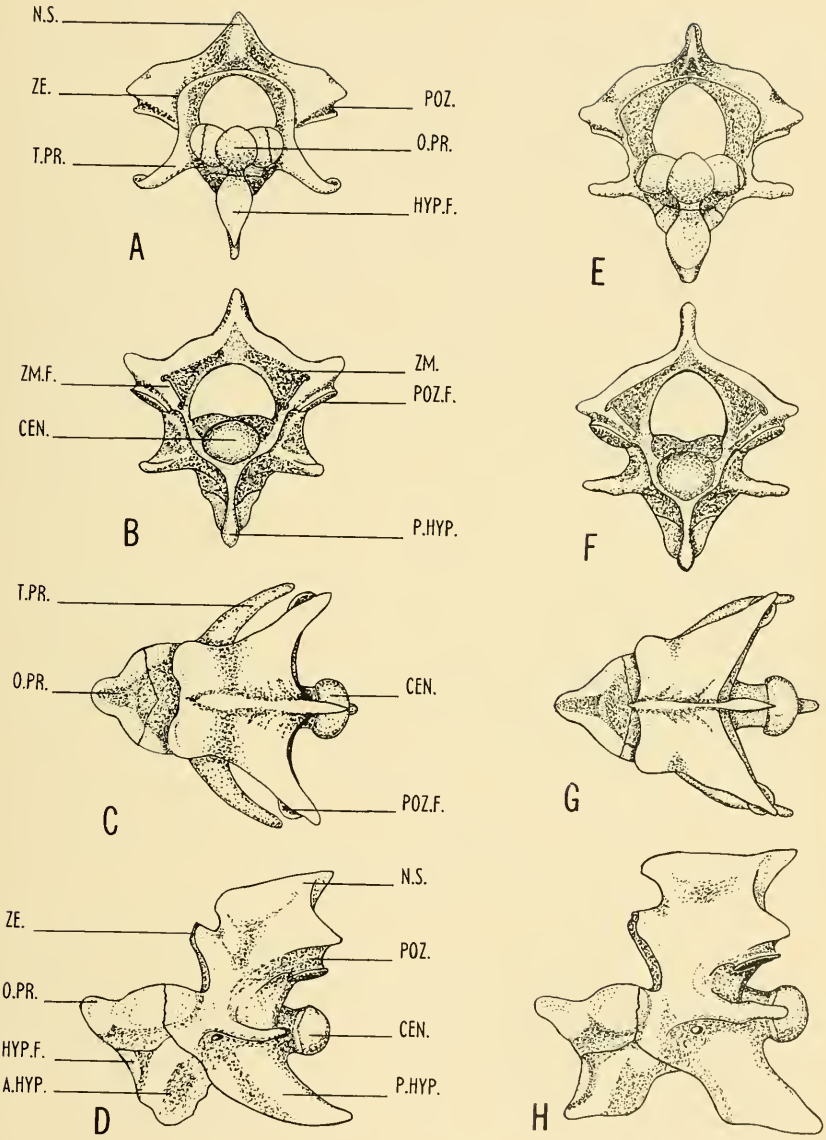

Fig. 2. Axis. *Pituophis catenifer*, A-D, 8X: A, anterior; B, posterior; C, dorsal; D, lateral. *Thamnophis radix*, E-H, 12X: E, anterior; F, posterior; G, dorsal; H, lateral.

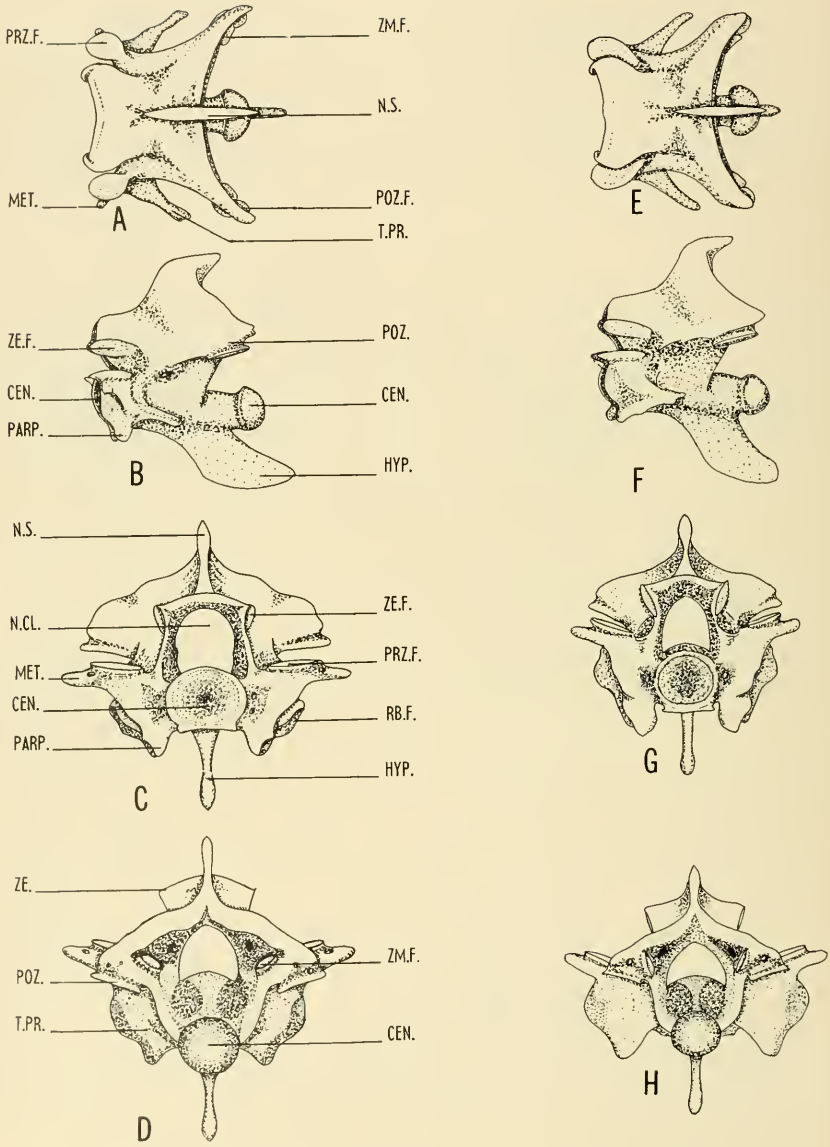

Fig. 3. *Pituophis catenifer*, A-D, 7X: A-B, first thoracic vertebra: A, dorsal; B, lateral; C-D, thoracic vertebra: C, anterior; D, posterior. *Thamnophis radix*, E-H, 9X: E-F, first thoracic vertebra: E, dorsal; F, lateral; G-H, thoracic vertebra: G, anterior; H, posterior.

ATLAS

Fig. 1-A, B, C and D

The first cervical vertebrae or atlas differs widely from the general vertebral pattern. It is a relatively narrow ring composed of three separate bones fused together by means of sutures. The two lateral neural arches or neurapophyses join dorsally as the sagittal neural suture; they form a pair of neurocentral sutures at their ventral borders where they unite with the intercentrum. There is no neural spine, but a rudimentary dorsal crest is developed. The centrum of the atlas actually coalesces with that of the axis leaving the atlas without a true centrum, its place being taken by the autogenous hypapophysis (Owen, 1866). Romer (1956) stated that the atlas has been robbed by the axis of its centrum, but has retained its intercentrum. Anteriorly the intercentrum presents a concave articular surface which articulates with the basioccipital tubercle of the occipital condyle. Posteriorly a similar surface adjoins the ventral surface of the odontoid process, as well as the interior facet of the anterior hypapophysis of the axis. Posteroventrally the intercentrum develops a small conical hypapophysis.

The base of each neural arch half possesses an anteromesial, concave articular surface which receives the exoccipital tubercle of the occipital condyle, and a posteromesial surface which articulates with the dorsal and lateral convex portions of the odontoid process. Each neural arch half carries a short postzygapophysis from the lateral border of its dorsoposterior region, and from its ventrolateral border a short conical transverse process points posteriorly. The neural canal is formed by the dorsal expansion of the neural arch, while the smaller ventrally located condylar or odontoid canal is formed between the mesial concave articular surfaces of the arch and the dorsal surface of the intercentrum. The two canals are partially separated by a tough transverse ligament extending from the dorsomesial border of one neural arch half facet to the other. The intervertebral foramina are formed when the notches in the posteroventral edges of the neural ring of the atlas come in contact with the anteroventral neural ring notches of the adjacent axis.

AXIS

Fig. 2-A, B, C and D

The axis has a very stout and elongate centrum which protrudes anteriorly, forming the odontoid process, and terminates posteriorly as a ball-like articulating condyle. The odontoid process is a separate cone-shaped bone connected to the main centrum and the anterior hypapophysis by a broad, curved suture. The apex of the odontoid has a rounded process which extends through the odontoid cavity of the atlas and rests lightly upon the basioccipital portion of the occipital condyle. The lateral articular surfaces of the process are convex and are received between and articulate with the posteromesial neural arch facets of the atlas.

The neural arch of the axis develops an elongate, posteriorly-projecting, ribless, transverse process from each side of its base, a partially developed zygosphene from the anterior dorsolateral border of each side, and a moderately long, posteriorly-projecting neural spine from its coalesced dorsal surface. The posterolateral expansions of the neural arch form the zygantrum internally and the postzygapophyses externally. The postzygapophyses contain flat, oval-shaped facets pointing ventrolaterally from the expanded surfaces, whereas the zygantrum has two similarly shaped articulating surfaces excavated from the inner surface of these same expansions, which point in a dorsomesial direction. The postzygapophyses articulate with the prezygapophyses of the first thoracic vertebra while the zygentral facets articulate with the zygosphenal surfaces of the same thoracic vertebra.

There are two hypapophyses developed on the ventral surface of the axis. The anterior one is sutured to the ventral border of the odontoid process as well as the anterior border of the posterior hypapophysis. It is somewhat triangular in shape with its curved dorsal suture representing the base of the triangle, and its apex pointing ventrally. The anterior vertical border contains an elongate, oval facet which articulates with the intercentrum of the atlas. The posterior hypapophysis is an elongate spinelike process developed on the midventral aspect of the centrum which points obliquely posterior.

FIRST THORACIC VERTEBRA

Fig. 3-A and B

The first thoracic vertebra lacks free ribs and is also otherwise modified. It differs from the other thoracic vertebrae in possessing a rather elongate, transverse process much like that of the axis, a fairly long, narrow, posteriorly-pointing, bladelike neural spine, and in the absence of articular surfaces for the attachment of ribs. The transverse process of these vertebrae is considered by Romer (1956) to be partially composed of short fused ribs. He therefore states that they can be referred to as "cervical" vertebrae. Other structures developed on this first thoracic verte-

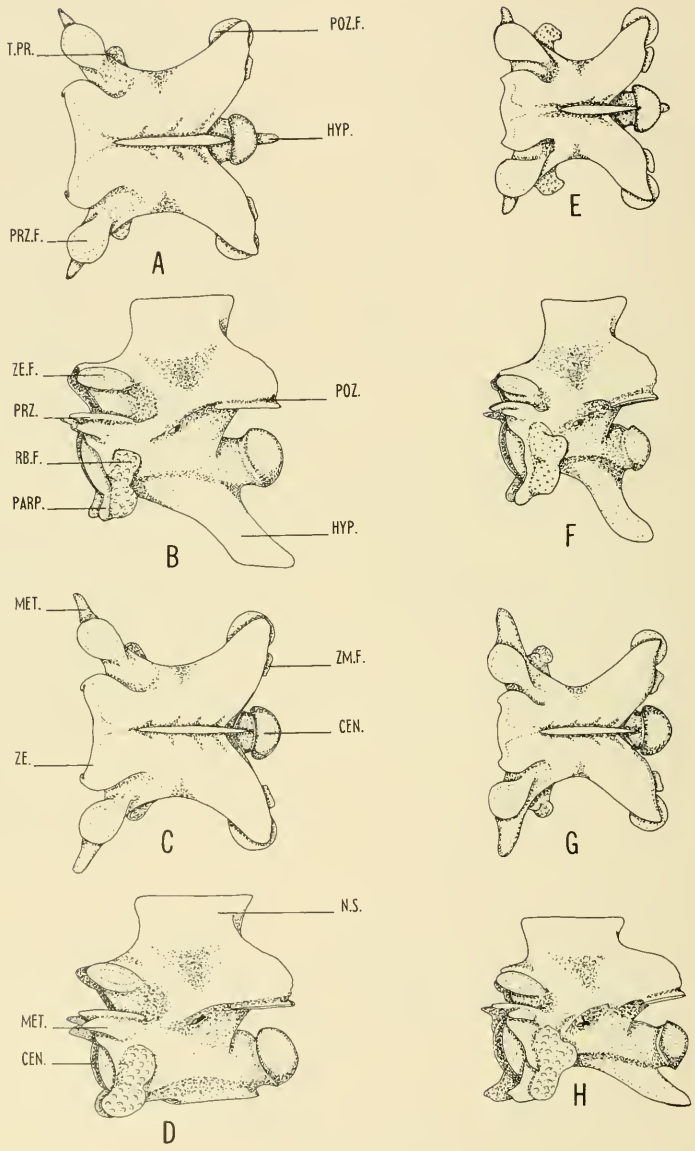

Fig. 4. *Pituophis catenifer*, A-D: A-B, thoracic vertebra, 7X: A, dorsal; B, lateral; C-D, lumbar vertebra, 6X: C, dorsal; D, lateral. *Thamnophis radix*, E-H: E-F, thoracic vertebra, 9X: E, dorsal; F, lateral. G-H, lumbar vertebra, 7X: G, dorsal; H, lateral.

bra are similar to the other more typical vertebrae of this subregion and are discussed in connection with them.

OTHER THORACIC VERTEBRAE

Figs. 3-C and D, 4-A and B

The typical thoracic vertebrae are strong and blocklike, being wider than they are long. The number of these vertebrae varied from fifty to fifty-three in the specimens of *P. catenifer* studied, but averaged approximately fifty-two in number. The centrum is not round, but rather compressed dorsoventrally. Its anterior face bears a concavity, the vertebrae being procelous. The socket faces a little ventrad from the greater prominence of the upper border; the prominent ball terminates the back part of the centrum rather more obliquely, its aspect facing somewhat upward. Ventrally the centrum bears an elongate median hypapophysis extending posteroventrally, and terminating slightly posterior to the condyle of the centrum. The transverse processes are short, bilobed structures arising from the anterolateral portions of the centrum, and extending ventrally in an obliquely posterior direction. The major portion of each transverse process is covered by the rib articular surface. The dorsal lobe of each process is a convex surface, whereas the ventral area is flattened and even slightly concave. The area of the transverse process which extends ventrally and anteriorly below the level of the centrum is referred to as the parapophysis.

The neural arches are broad, swollen structures facilitating the arrangement of the zygapophyses, whose nearly horizontal articular surfaces are placed far apart from each other at a level not far above the floor of the neural canal. The oval, transversally elongate facet of each prezygapophysis is supported by a lateral process arising from the dorsal aspect of the transverse process, and is facing dorsad. Sood (1948) noticed that each prezygapophysis supported a lateral projection pointing outwardly and slightly forward, serving as a point of attachment for muscles, and seemed to correspond to the metapophysis of mammals.

A wedge-shaped process, the zygosphene, is developed from the anterior border of the base of the neural spine and bears two smooth, oval, flat articular surfaces. These zygosphenal facets extend from the ventral apex of the wedge (sloping dorsolaterally) to its dorsolateral borders. This wedge is received into the cavity (zygantrum) containing the zygantral facets, which is excavated in the posterior expansion of the neural arch of the preceding vertebra. The zygosphenal surfaces are adapted to articulate with those of the zygantra.

The postzygapophyses and zygantra of the thoracic vertebrae are very similar to those of the axis except for their being slightly larger and more horizontally placed.

The neural spine is of moderate height, placed about equidistant in its anteroposterior extent on the vertebra, and is laterally compressed and truncate.

There are typically two sets of foramina in the vertebral column—the intervertebral and the intravertebral (Sood, 1948). The intervertebral foramina have already been mentioned in connection with the atlas and axis, but they are found along the entire column between contiguous vertebrae. When viewed laterally each foramen is composed of two apertures—a dorsolateral, superior intervertebral foramen and a ventrolateral, inferior intervertebral foramen. The zygapophysial articulation separates the single intervertebral foramen into its superior and inferior external apertures. A feature not noted previously is the presence of several pairs of intravertebral foramina in addition to the pair of minute apertures situated ventrally in the middle of each centrum on either side of the median longitudinal line. These additional intravertebral foramina are located as follows: a foramen on the dorsal surface of the proximal portion of each metapophysis, a foramen in the middle of the base of each lateral wall of the neural arch, a foramen or pair of foramina on each side of the anterior central articular socket, and several pairs of minute foramina on the roughened ridge dorsal to each postzygapophysis. These foramina are found not only in the thoracic vertebrae, but are common to most vertebrae in all of the subregions.

LUMBAR VERTEBRAE

Fig. 4-C and D

The lumbar vertebrae vary in number from 183 to 187 in the specimens studied. These vertebrae lack hypapophyses, but possess a small, rudimentary mid-ventral ridge. Most vertebrae are slightly larger and heavier than those of the thoracic subregion, but with the exception of lacking hypapophyses, they are morphologically very similar.

ANTERIOR CAUDAL VERTEBRAE

Fig. 5-A, B, C and D

In general structure these five or six vertebrae resemble those of the precaudal series. The

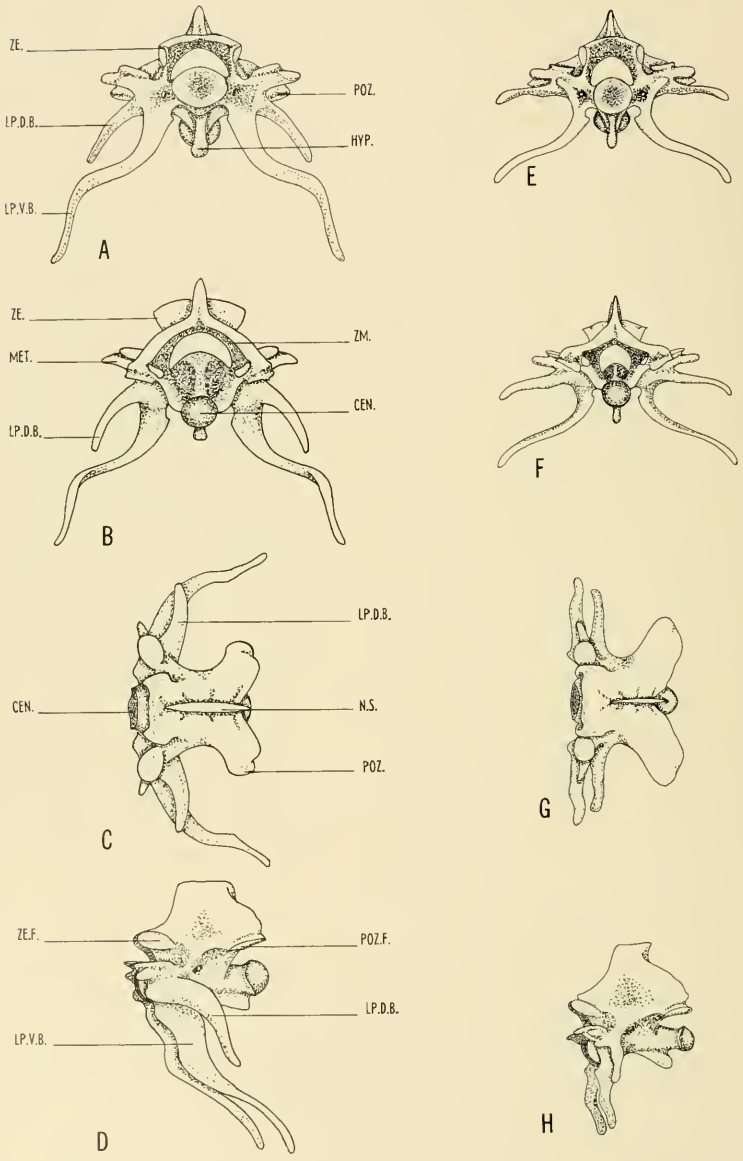

Fig. 5. Anterior caudal vertebra, 6X. *Pituophis catenifer*, A-D: A, anterior; B, posterior; C, dorsal; D, lateral. *Thamnophis radix*, E-H: E, anterior; F, posterior; G, dorsal; H, lateral.

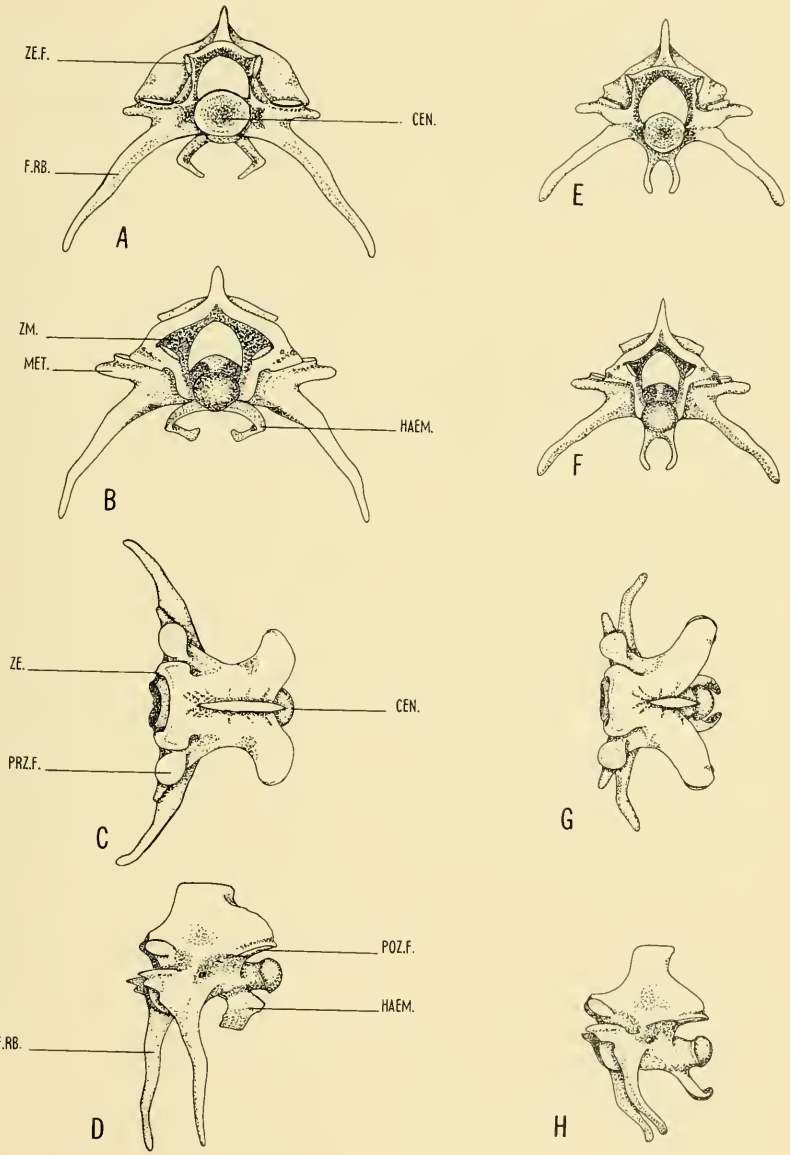

Fig. 6. Middle caudal vertebra, 6X. *Pituophis catenifer*, A-D: A, anterior; B, posterior; C, dorsal; D, lateral. *Thamnophis radix*, E-H: E, anterior; F, posterior; G, dorsal; H, lateral.

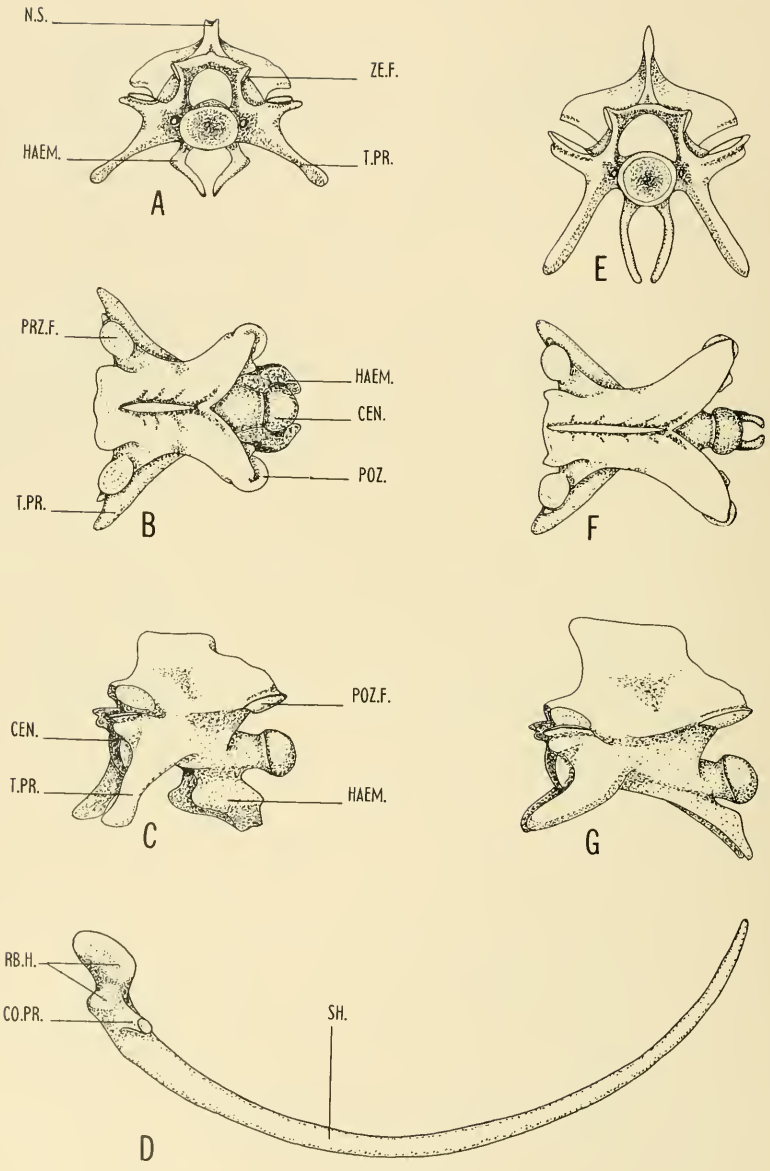

Fig. 7. *Pituophis catenifer*, A-D: A-C, posterior caudal vertebra. 10X: A, anterior; B, dorsal; C, lateral; D, rib, lateral. 5X. *Thamnophis radix*, posterior caudal vertebra, E-G, 12X: E, anterior; F, dorsal; G, lateral.

region can be distinguished, however, by the absence of free ribs and the presence of fused or articulating bifurcated ribs called lymphapophyses. In the younger specimens studied the lymphapophyses of the first anterior caudal vertebra articulate with the body of the vertebra, as do the preceding ribs of the lumbar vertebrae. In the majority of the older and more mature specimens the articulating surfaces were somewhat fused, and in most incidences the lymphapophyses were not free to move in the same manner as articulating ribs. In a few of the mature specimens the only evidence of the previous articulation is a groove around the base of the lymphapophyses. The lymphapophyses of the remaining vertebrae of this subregion do not articulate or demonstrate any superficial indication of such.

These bifurcated structures (lymphapophyses) are associated with muscle attachment as well as with the large lymph hearts on either flank; the divided processes extend outward, dorsal and ventral to the hearts. The more ventral branch is an elongate hornlike process pointing posteroventrally. The dorsal branch is much shorter and arcs in a ventrolateral direction. The dorsal and ventral branches of these vertebrae, however, do show some degree of morphological modification from vertebra to vertebra and from specimen to specimen. Both branches show continuity in becoming reduced in size as they progress posteriorly. The dorsal branch is reduced to the point of becoming nonexistent in the middle caudal subregion, but the ventral branch remains in its reduced form throughout the remaining caudal region. The first one or two vertebrae of this subregion have developed a small ridgelike hypapophysis, but are devoid of haemapophyses. In *P. catenifer*, however, the last few vertebrae of this section possess a pair of flat, platelike, curved haemapophyses projecting ventrally from the posterior part of each centrum. These structures are considered to be chevrons by Romer (1956), and serially homologous with the hypapophyses of the precaudals.

There was no apparent indication of sexual dimorphism in the vertebrae of this (cloacal) area.

MIDDLE CAUDAL VERTEBRAE

Fig. 6-A, B, C and D

These three or four vertebrae differ from the anterior caudals in possessing unforked, fixed ribs which are relatively long and only moderately curved. Although in Sood's criteria for this subregion the vertebrae lack haemapophyses, both colubrid snakes involved in this study possessed them. The possession of haemapophyses by middle caudals makes it rather difficult to distinguish between the last few vertebrae of this group and the first few vertebrae of the posterior caudal subregion.

POSTERIOR CAUDAL VERTEBRAE

Fig. 7-A, B and C

The number of vertebrae involved in this subregion vary greatly from specimen to specimen; however, an average range is fifty-five to sixty-five. These vertebrae are similar in general pattern to the middle caudals, but they gradually diminish in size until the last few are rudimentary. Their processes also show a gradual reduction in size until they are almost vestigial near the tip of the tail.

Although the demarcation between these vertebrae and the middle caudal group is somewhat arbitrary, it is possible to separate the two areas by the length and direction of the fixed ribs (transverse processes) as well as the structure of the haemapophyses. In this latter caudal group the transverse processes point anteroventrally; the fixed ribs of the middle caudals point either ventrally or posteroventrally, and are longer. The apices of the haemapophyses approach each other mesially until they almost touch in the anterior portion of the posterior caudals, whereas they are farther apart and more rudimentary in the middle caudals of the majority of the specimens studied. About midway along the posterior caudals, the haemapophyses undergo a transition whereby they project almost straight downward in a posteroventral direction with little or no inward curve, remaining rather widely separated at their distal ends.

RIBS

Fig. 7-D

All of the precaudal vertebrae, except the atlas, axis, and first thoracic, articulate with a pair of vertebral ribs (pleurapophyses). The ribs in the middle of the body are longer and heavier than the first and last few pairs. They are terete, curved, pointed, and are so articulated that they move freely in an anteroposterior plane. Each articulates with the anterior edge of the centrum, the head being connected with the bilobed transverse process. Although the rib head is single, the articular surface is divided into a flattened ventral portion and an adjacent dorsal cupped area. The rib head does not develop a

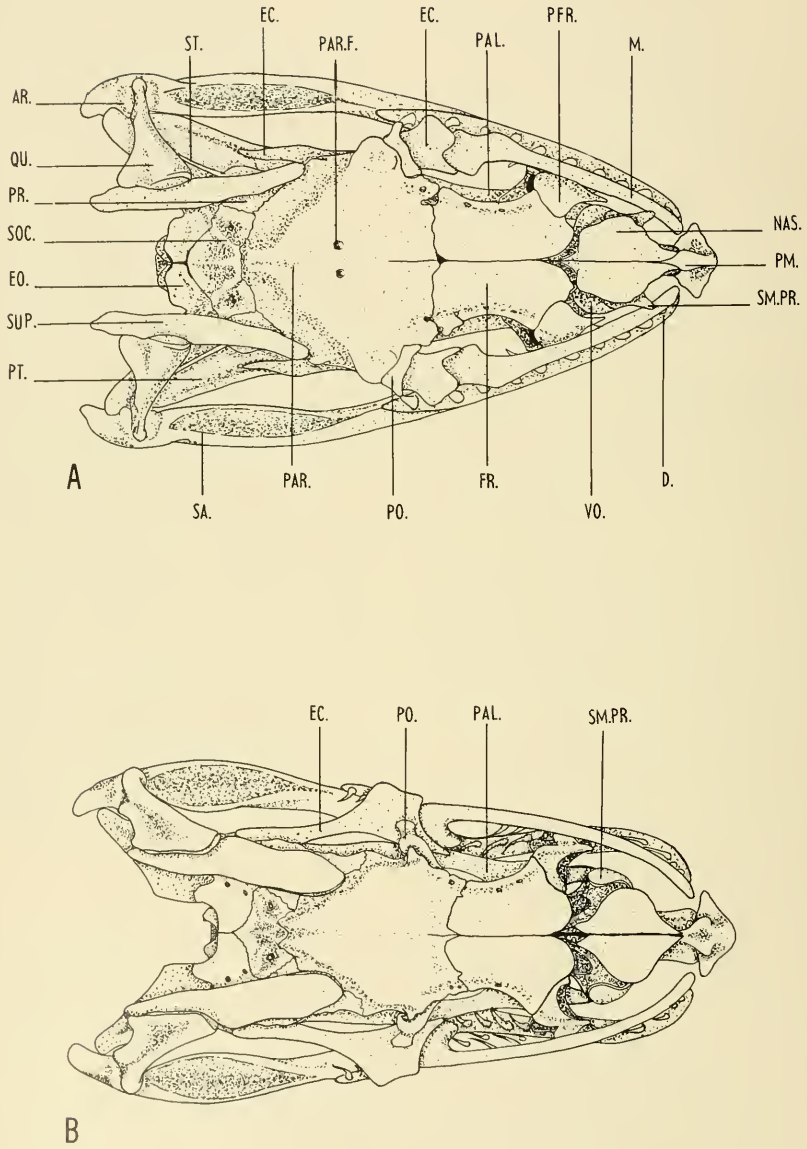

Fig. 8. Skull, dorsal. A, *Pituophis catenifer*, 4X. B, *Thamnophis radix*, 5X.

true capitulum or tuberculum as is characteristic of higher vertebrates. Distal to the head there is a posterodorsally-directed costal process for the attachment of muscle fibers.

SKULL

The skull of *P. catenifer* is well ossified and the bones are dense; the cranium is relatively long and broad, and the brain cavity extends between the orbits. The apparent large size of the head is partially due to the arrangement of the supratemporals, quadrates, and mandibular structures. The bones making up the skull are for the most part loosely articulated, thus making possible a greater flexibility in the mouth region.

PREMAXILLA

Figs. 8-A, 9-A, 10-A

The premaxilla is a single, small median bone which terminates the snout. Its anterior surface is an inverted Y-shaped ridge, the prongs of which extend in a ventrolateral direction. The dorsal process of the ridge curves posteriorly and wedges between the anterior portion of the two nasals. From the ventral crotch of the "Y" there is a horizontal platelike process, terminally bifurcated, extending posteriorly. Its dorsal surface articulates with the ventral surfaces of the anterior septomaxillary processes, thus forming the roof of the anterior portion of the mouth. The premaxilla does not bear teeth.

NASALS

Figs. 8-A, 9-A, 10-A

From a dorsal view the articulated nasals appear as an ovalshaped structure between the premaxilla and the frontals, and are loosely connected to them by connective tissue. The nasals separate anteriorly to form an interspace, which receives the dorsal process of the premaxilla, but remain connected posteriorly, forming a pointed process which is received into the anterior cleft between the two frontals. Dorsally the nasals do not articulate with the frontals. The nasals sheath the nasal cavities dorsolaterally, and form a double median septum between them. This vertical septum extends posteroventrally as a process which comes in contact with the fused anteroventral borders of the frontals. The posterior portion of the septum is in contact with the dorsal surface of the septomaxillae.

SEPTOMAXILLAE

Figs. 8-A, 9-A, 10-A

The elongate, horizontal, platelike septomaxillae form the floor of the internal nares. They are in contact dorsally with the nasals, anteriorly with the premaxillae, ventrally with the vomers, and posteriorly with the frontals. The septomaxillae lie close together near the mid-dorsal line, but do not suture. Their posterior extremities turn ventrad and come in contact with the frontals. A pair of horizontal winglike processes extend laterally from about the middle of each bone, become narrow, and turn dorsally until they almost touch the descending dorsolateral borders of the nasals.

VOMERS

Figs. 8-A, 9-A, 10-A

The edentulous vomers are connected to the ventral surfaces of the septomaxillae; at this union they form a pair of hollow, spherical vomeronasal organs which open by paired orifices into the buccal cavity. The inner margins of the vomers do not suture, but are joined to adjacent elements only by connective tissue. Each vomer has three vertically-flattened processes extending from its flat mesial border—an anterior process connected to the septomaxilla, a posterior process connected to the mesial surface of the posteroventral process of the nasal and the posterior process of the septomaxilla, and a larger posteroventral process with a large triangular fenestra occupying most of its area. The posteroventral process does not articulate with any skull structures, but is connected by connective tissue to other adjacent elements.

FRONTALS

Figs. 8-A, 9-A, 10-A

The frontals are highly developed and form a complete enclosure for the anterior portion of the brain. They remain separate, but are joined mesially by the sagittal suture. The dorsal surface of each frontal is flat, subquadrate, longer than broad, and there is a groove in each, parallel with the indented orbital edge. This groove is perforated with several supraorbital foramina in the adult forms. In younger snakes some of these foramina are not completely formed, but are mere indentations from the orbital margin. The anterolateral edge has a small, depressed articular surface to which the prefrontal is loosely at-

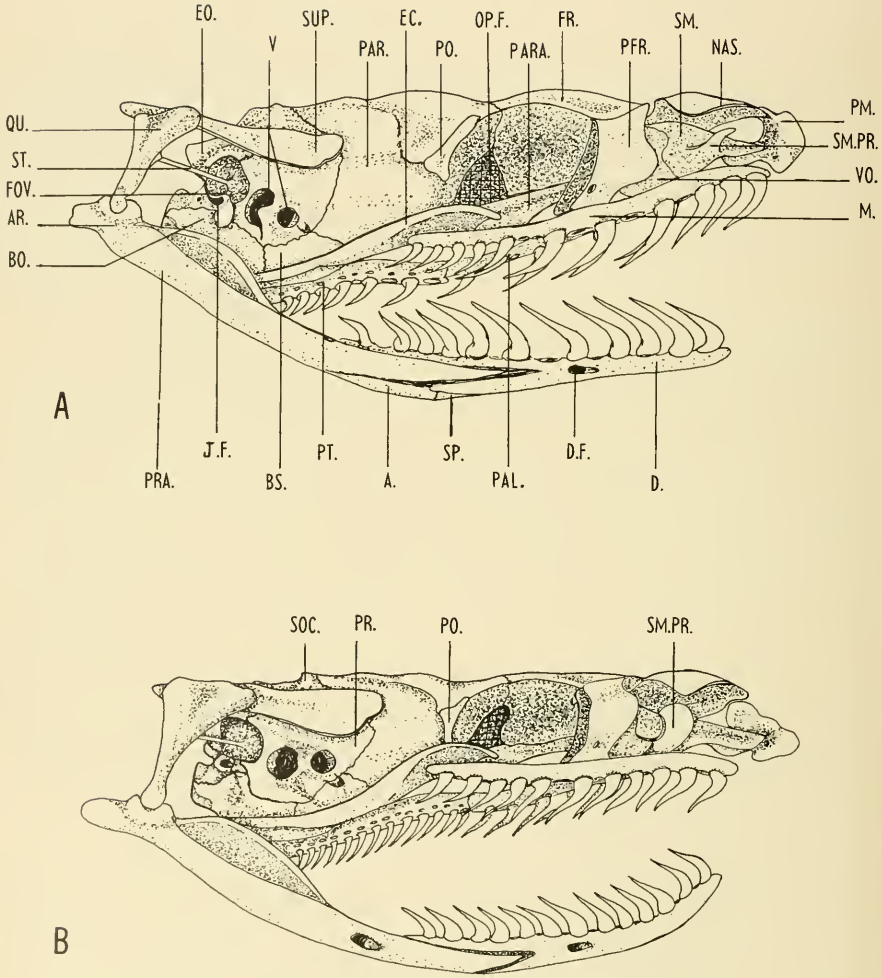

Fig. 9. Skull, lateral. A, *Pituophis catenifer*, 4X. B, *Thamnophis radix*, 5X.

tached. The lateral surface, considered to be the orbitosphenoidal plate of the frontal, joins the dorsolateral margin of the frontal at an acute angle, thus forming a major portion of the mesial wall of the orbit. Ventrally the descending walls rest upon the presphenoidal prolongation of the basisphenoid, completing the orbital septum and cranial floor. Each wall is notched posteroventrally where it sutures with the anterior wall of the parietal, thus forming the anterior portion of each orbital or optic foramen. Through these foramina pass the optic nerves, eye-muscle nerves, and blood vessels. Anteriorly, where the frontals contact the nasals and septomaxillae, two large canals or ethmoid foramina, to facilitate the passage of olfactory nerves, are formed by way of a vertical, median double lamina (one from each frontal).

PREFRONTALS

Figs. 8-A, 9-A, 10-A

Although some early workers considered the lacrimals to be present in snakes, Romer (1956) stated that "lacrimals are absent; a foramen or groove for the lacrimal duct is present in the prefrontal." According to Gregory (1913), the prefrontal of reptiles is not homologous with the lacrimal of mammals.

From a lateral view each prefrontal is an irregular cone-shaped structure with a laterally compressed anterior process (forming the apex of the cone) extending laterally to the posterior portion of the nasal, septomaxilla, and vomer. The prefrontals loosely articulate with the anterolateral surfaces of the frontals, forming the anterior edge of each orbit. A rather large lacrimal foramen or duct is located on the ventral border of each prefrontal near its articulation with the dorsal surface of the maxilla.

PARIETALS

Figs. 8-A, 9-A, 11-C

Posteriorly the frontals articulate with the fused (coalesced) parietals, there being some degree of motility between the frontals and the parietal. The parietal is the largest of the cranial elements and forms the greater part of the braincase roof, but like the frontals, extends far down either side of the brain, reaching ventrally to the basisphenoid and forming the posterior portion of each orbit. The posterolateral borders of the parietal suture with the prootics. The triangular-shaped, dorsal surface has its narrow apex attached to the supraoccipital posteriorly. Dorsally a V-shaped pair of crests converge posteriorly near the supraoccipital articulation. The posterodorsal surface of each orbit is expanded laterally by the parietal into a flattened lobelike process, the lateral border of which articulates with the curved mesial surface of the postorbital. A smaller coneshaped process, ventral to the lobelike process, articulates dorsally with the posteroventral border of the postorbital. About midway down the coalesced sagittal suture, there are two small parietal foramina immediately lateral to the midline.

POSTORBITALS

Figs. 8-A, 9-A, 11-C

The small postorbitals, considered to be postfrontals by Owen (1866) and Kellicott (1898), are narrow, elongate flattened bones which articulate with the anterolateral surfaces of the parietal, and form the dorsoposterior boundary of each orbit. A strong ligament connects the posterior part of each postorbital with the anterodorsal surface of the ectopterygoids.

SUPRAOCCIPITAL

Figs. 8-A, 9-A, 11-C

The small butterfly-shaped supraoccipital is medially placed and unites anteriorly with the parietal, laterally with the prootics, and posteriorly with the exoccipitals. It forms the roof of the posterior part of the brain cavity, and is internally expanded from its lateral wings to form the dorsal portion of each otic capsule. The lambdoidal ridge or nuchal crest is prominent, and extends obliquely posterolaterally down each side of the posterior portion of the cranium. Each lateral branch of the crest diminishes in size near the exoccipital articulation, but continues as a rather sharp ridge along the anterior border of the exoccipital, terminating at the posterior border of the fenestra ovalis. Dorsally a short median longitudinal ridge extends posteriorly, ending where the mid-dorsal suture joins the exoccipitals.

PROOTICS

Figs. 8-A, 9-A, 11-C

Each prootic is an irregular quadrate-shaped bone forming the anterior part of the internal otic capsule and the posterolateral wall of the braincase. It is bordered by the parietal anteriorly, supraoccipital dorsally, exoccipital posteriorly, and the basisphenoid and basioccipital ventrally. The anterior half of each fenestra ovalis is formed by the prootic; the exoccipital completes the fenestra posteriorly. The foramen is basically for the passage of the trigeminus, but

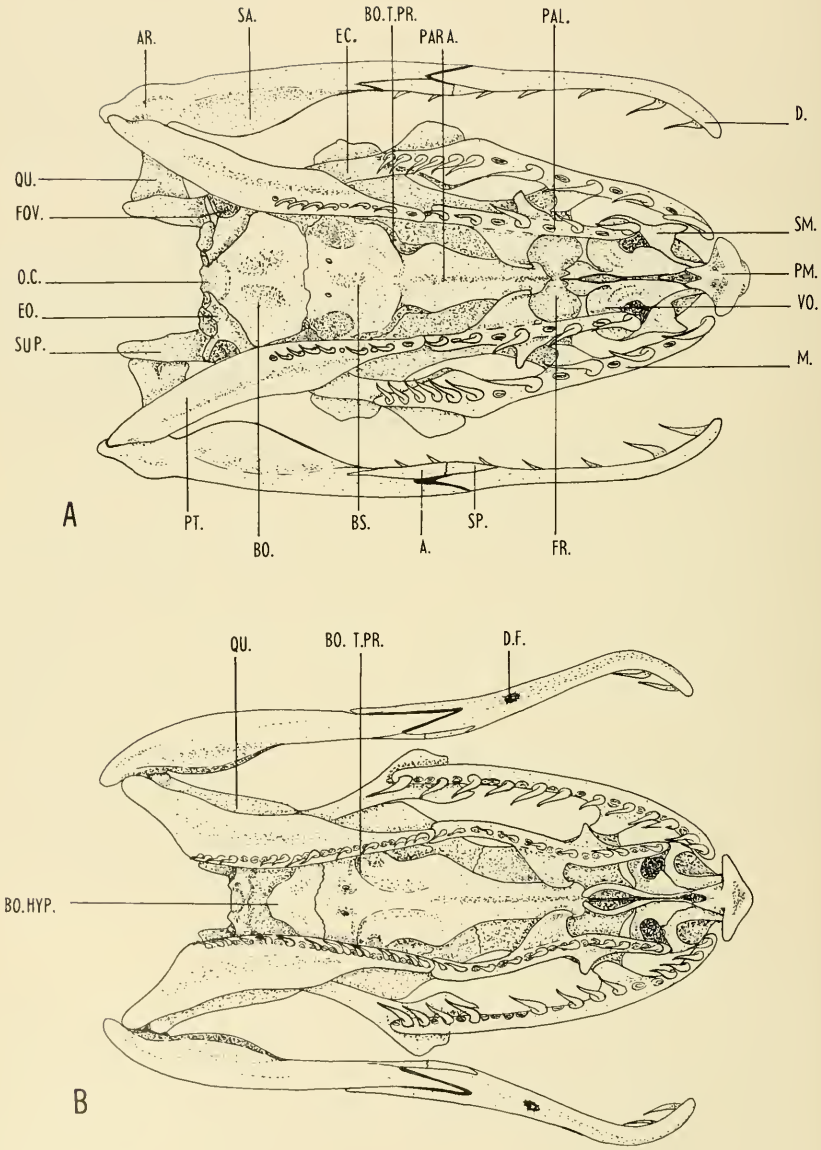

Fig. 10. Skull, ventral. A, *Pituophis catenifer*, 4X. B, *Thamnophis radix*, 5X.

also carries some facial nerve fibers. It is divided externally into two openings, both anterior to the fenestra ovalis. The posterior foramen is larger than the anterior one, and has a lateral process projecting posteriorly from its anterior border, therefore partially obscuring the opening. Other smaller foramina pierce each prootic, carrying cranial nerve fibers.

EXOCCIPITALS

Figs. 8-A, 9-A, 10-A, 11-C

The exoccipital bones form the posterolateral walls of the braincase as well as part of its roof. They are joined together by a mid-dorsal suture, connected to the supraoccipital and prootics anteriorly, and resting upon the basioccipital ventrally. The opisthotics are fused with the exoccipitals, the combined bone thus surrounding the jugular foramen and extending forward to form the posterior border of the fenestra ovalis (Romer, 1956). This jugular foramen, which is internally subdivided into two or more smaller aspects, is just posterior to the fenestra ovalis, and is used for the passage of the ninth and tenth cranial nerves. Posteriorly the exoccipitals form the entire dorsoventrally-compressed, oval foramen magnum, except for a small ventral portion of the occipital condyle. Posteroventrally the exoccipitals terminate as a pair of articulating tubercles which form the lateral portions of the crescent-shaped occiptal condyle.

BASIOCCIPITAL

Figs. 9-A, 10-A, 11-C

The basioccipital is a pentagonal-shaped bone forming the floor of the posterior part of the brain cavity. The ventral surface has a low, sagittal ridge with a laterally depressed area on either side. Posteriorly a midventral tubercle forms the ventral portion of the occipital condyle, thus completing the foramen magnum. The basioccipital is bordered laterally by the exoccipitals, and is joined anteroventrally with the basisphenoid.

BASISPHENOID

Figs. 9-A, 10-A

In the skull of adult serpents, the basisphenoid is applied without a suture anteriorly to the elongate parasphenoid, forming a single bone. The basisphenoidal portion of the bone is a flat, hexagonal plate, bounded dorsally at its margins by prootic and parietal walls, and posteriorly by the basioccipital. A pair of prominent transverse processes extend obliquely and anteriorly toward the midline from its ventrolateral surfaces. Paired carotid foramina pierce the bone laterally to each process to enter the pituitary fossa. This fossa is seen ventrally as a convex area, and is the floor of the sella turcica in which the pituitary gland lies. A pair of foramina also pierce the posterolateral borders of this bone.

The narrow elongate parasphenoidal portion of the basisphenoid extends anteriorly into the rostrum area, and becomes the floor of the orbit and optic foramen. A median longitudinal groove extends the entire length of the ventral surface, whereas a dorsomesial keel is wedged between the ventral connection of the frontals.

MAXILLAE

Figs. 8-A, 9-A, 10-A

Each maxilla is a short, curved bar that conforms to the shape of the head. On the mesial border, about midway, there is a small horizontal dorsoposteriorly-pointing process that articulates with the ventral surface of the prefrontal. The posterior end of the maxilla is broadened somewhat, and is received by the flattened club-shaped ventral surface of the ectopterygoid. Each maxilla bears sockets for about fifteen or sixteen curved teeth, but not all of the sockets contain rigidly fixed teeth; therefore, some are usually lost in the preparation of the skull. In *P. catenifer* about every other tooth on the maxillae, as well as the other tooth-bearing structures, was only loosely lodged in the grooves and could be removed very easily. The maxillae are connected by fibrous tissue to the premaxillae, and not by an osseous articulation as in most vertebrates.

ECTOPTERYGOIDS

Figs. 8-A, 9-A, 10-A

The ectopterygoids, which were sometimes referred to as the transpalatines by earlier workers such as Kellicott (1898) and Wiedersheim and Parker (1907), are small club-shaped, flat bones connecting the maxillae to the pterygoid, and overlying each at its ends. Each flattened spatulatelike anterior process is notched anteriorly where it ligamentously articulates with the maxilla, and an elongate, posterior end articulates with the dorsolateral groove in the pterygoid which runs parallel with the curved contour of this bone for its entire length. The ectopterygoids do not bear teeth.

PALATINES

Figs. 9-A, 10-A

The palatines are short bars placed anteriorly to the pterygoids, and mesially to the maxillae,

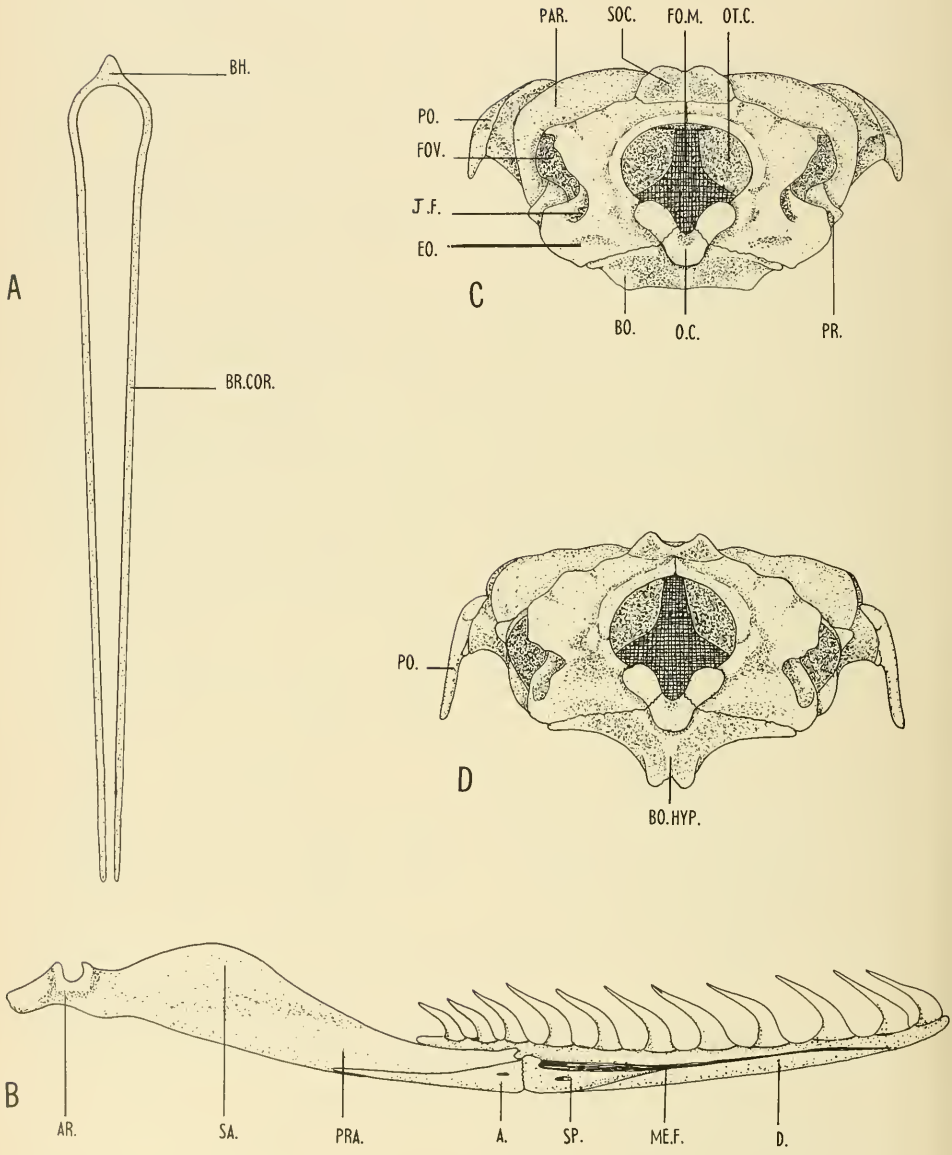

Fig. 11. *Pituophis catenifer*, A-C: A, hyoid apparatus, ventral, 4X; B, mandible, medial, 5X; C, cranium, posterior, 5X. D, *Thamnophis radix*, cranium, posterior, 9X.

each bearing nine or ten teeth. The posterior end of each palatine articulates with the anterior end of the pterygoid. About midway each palatine possesses a broad, flattened, horizontal, median process with apex directed anteriorly, and a similar but narrower lateral process articulating with the ventral border of the prefrontal. The palatines are connected by fibrous connective tissue to the snout elements.

PTERYGOIDS

Figs. 8-A, 9-A, 10-A

Each pterygoid is a curved, flattened bar extending from the palatine posterolaterally to the angle of the mandible. Anteriorly it narrows and forms a loose articulation with the posterior end of the palatine. From this articulation a row of eight to twelve teeth extends posteriorly along the medial border, extending about midway. The pterygoid receives the ectopterygoid into an elongated, dorsolateral groove. Posteriorly the pterygoid narrows into a slender, curved process that reaches the base of the quadrate as well as the mandible.

SUPRATEMPORALS

Figs. 8-A, 9-A, 10-A

The supratemporals are not true squamosals as some of the earlier writers indicated (Romer, 1956). Owen (1866) referred to them as mastoids, but this terminology has been dropped in favor of the more applicable term (supratemporal) used in this paper. The problem of the homologies of the squamosal, supratemporal, etc., is, however, far from being solved in the various reptile groups, as pointed out by Jollie (1960).

Each supratemporal is a short, narrow, flattened bone connecting the posterolateral dorsal part of the skull with the proximal end of the quadrate. Anteriorly each supratemporal overlays a portion of the parietal, prootic, supraoccipital, and exoccipital, and is attached to these cranial elements by fibrous connective tissue. The two bones are almost parallel to each other, converging only slightly as they extend posteriorly.

QUADRATES

Figs. 8-A, 9-A, 10-A

Each quadrate is a strong, rectangular bone; its proximal surface articulates with the posterolateral border of the supratemporal, and its distal, notched, condylar surface with that of the mandibular condyle. Its proximal surface is twisted to become obliquely aligned along the sagittal plane, whereas its concave distal articulating surface is extended transversely to form an intercondyloid fossa for mandibular articulation. About midway down the mesial side of each quadrate there is a small, rectangular, raised process which articulates with the distal end of the stapes.

MANDIBLE

Figs. 8-A, 9-A, 10-A, 11-B

The mandible is composed of two jaw bones which lack a firm anterior symphysis, but are connected by an elastic ligament anteriorly, and is held together posteriorly to the symphysis by the transverse muscles. Each jaw bone is long, curved anteromesially, and is separable into two major bones in the adult snake; however, the splenial and angular bones can sometimes be separated in addition to these two major elements. The longer proximal part of each jaw is composed of angular, prearticular, articular, surangular, and splenial aspects, and is without teeth. Although the splenial and angular are the only bones that can be separated from this proximal portion of the jaw, the other bones are coalesced and form the following areas: the articular and prearticular form the mandibular condyle area; the surangular expands into a longitudinal dorsomesial crest near the condyle, a deep lateral groove is formed at the base of the crest, and the inferior dental foramen opens at the bottom of the groove. The splenial and angular bones are triangular shaped with their bases together and their apices pointing anteriorly and posteriorly from their midventral location on the mesial surface of the jaw. The apex of the splenial points anteriorly; and owing to the reduction in its size, the anterior part of the meckelian canal becomes an open mesial groove in the dentary just anterior to the splenial.

Bogert (1943) uses the term postarticular when referring to the process of the articular that extends posteriorly from the mandibular articulation with the quadrate. His work was with the cobra and other elapids.

The dentary forms the anterolateral portion of the jaw, and contains a row of sixteen to eighteen of the usual hooked or recurved teeth. It is short, curved, pointed anteriorly, and bifurcated posteriorly on the lateral surface, thus articulating with the anterior projection of the proximal portion of the jaw. This contact between the two bones is not a close one; therefore, it gives a degree of flexibility to the jaw. The mental foramen is located near the middle of the lateral surface of the dentary.

STAPES

Figs. 8-A, 9-A

Each stapes (columella) is a delicate, slender, rodlike stylus connecting the otic capsule, by way of the fenestra ovalis, to the rectangular articular surface of the quadrate. Its proximal end is enlarged to form a footplate that fits into the foramen. The stapes is believed to transmit sound vibrations from the various jaw bones to the otic capsule.

HYOID APPARATUS

Fig. 11-A

The hyoid apparatus is a cartilagenous, V-shaped structure with its vertex or base (basihyobranchial) attached to the midventral raphe between the lower jaws; each rodlike branchial cornu extends posteriorly along the lateral border of the elongate tongue, being inserted into the base of one of the elongate retractor muscles. Superficial, ventral cranial muscles are attached to the basihyobranchial and the anterior portion of each cornu. The hyoid apparatus is not attached to any of the skull elements as it is in most other vertebrates, but lies imbedded in the muscle and fascia of the intermandibular region.

The tongue, along with its posteriorly continuing retractor muscles, is more than twice as long as the skull. The hyoid apparatus, therefore, is modified into a very long structure in this species even though it is a rather delicate organ.

OSTEOLOGICAL COMPARISONS

The two species considered in this study (*Pituophis catenifer* and *Thamnophis radix*) show many osteological similarities. There are, however, a few significant structural differences existing between them. Some of these differences appear to be highly correlated with the special adaptations made by the two species in becoming more compatible with their specific environments and food habits; however, there are many minor structural differences that would seem to be nonadaptive, or perhaps they may have other effects of survival value not apparent to the authors. Only those differences which appear to be of sufficient magnitude to be compared, and perhaps have some bearing on the adaptation of these two species, will be discussed.

A complete set of osteological illustrations for *Thamnophis radix*, corresponding to those of *Pituophis catenifer*, has been included and will be referred to in the course of the comparative discussion.

VERTEBRAL COLUMN

Precaudal Vertebrae

The atlas of *T. radix* (Fig. 1-E, F, G, and H) is proportionately broader along the sagittal, neural suture line (Fig. 1-G and H) than in *P. catenifer* (Fig.1-C and D), but its dorsoposterior projections containing the postzygapophyses are not as prominent. The hypapophysis of the atlas of *T. radix* (Fig. 1-H) does not point posteroventrally as it does in *P. catenifer* (Fig. 1-D), but instead is represented as a small vertical process extending ventrad from the ventral portion of the intercentrum.

The major differences in the axis of the two species are found in the anterior and posterior hypapophyses. In *T. radix* the axis (Fig. 2-E, F, G and H) develops a stout, hatchet-shaped, anterior hypapophysis (Fig. 2-H) with its anterior articular facet placed vertically on its anterior border, whereas the previously-mentioned, wedge-shaped, anterior hypapophysis of *P. catenifer* (Fig. 2-D) possesses a narrower posteroventrally situated facet. The posterior hypapophysis of *T. radix* (Fig. 2-H) is not as spinelike or tapered as in the other species, but is more trapezoid in shape with its ventral margin being somewhat truncate.

Some of the less obvious differences existing in these vertebrae are the proportionally narrower odontoid process (Fig. 2-G), the more posteriorly placed, dorsoventral odontoid suture (Fig. 2-G and H), and the greater anteriorly projecting portion of the neural spine (Fig. 2-H) in *T. radix*.

In *T. radix* the first thoracic vertebra (Fig. 3-E and F) lacks free ribs, just as it does in *P. catenifer*. The fixed ribs or transverse processes, however, are short, and extend posteriorly in both species. In the majority of the specimens studied, the transverse processes of the first thoracic vertebrae were a little thicker at the base, and less spinelike in *T. radix* (Fig. 3-F). This species also differs from *P. catenifer* in that the neural spine is narrower and slightly longer (Fig. 3-F), the anterior zygapophyses are placed

more mesially and are partially covered by the zygosphenes when viewed dorsally (Fig. 3-E), and there is a complete lack of metapophyses.

The other thoracic or typical thoracic vertebrae show few noticeable differences between the two species. It can be observed, however, that in *T. radix* these twenty-two or twenty-three thoracic vertebrae (Figs. 3-G and H; 4-E and F) develop proportionally smaller metapophyses but larger transverse processes (Fig. 3-G and H). The dorsal convex portion of the transverse process, bilobed rib, articular surface projects more laterally (Fig. 4-E and F), and the facets of the anterior zygapophyses are tilted slightly more obliquely dorsad (Fig. 3-G) in *T. radix* than those of *P. catenifer* (Fig. 3-C).

The lumbar vertebrae of *T. radix* (Fig. 4-G and H) retain relatively large hypapophyses (Fig. 4-H), whereas the hypapophyses of *P. catenifer* (Fig. 4-D) are lacking in this region, and are represented only by rudimentary midventral ridges. The presence of hypapophyses on the lumbar vertebrae of *T. radix* makes it very difficult to distinguish the first few vertebrae of this subregion from the last two or three thoracics. However, there is a decisive reduction in the length of the hypapophyses extending over three or four vertebrae, making it possible to distinguish between the two vertebral areas with a relative degree of consistency. In *T. radix* there is an average of approximately 136 or 137 lumbar vertebrae, compared to 185 or 186 found in *P. catenifer*. The lumbar vertebrae of *T. radix* (Fig. 4-G and H) develop transverse processes much like those of the thoracic vertebrae. The dorsal rib facets are placed more dorsally (Fig. 4-H), and are more prominent laterally (Fig. 4-G) than in *P. catenifer*. In this species the ventral apex of each transverse process (parapophysis) is devoid of a rib articular surface, and thus forms an anteroventrally projecting process similar to those found on the thoracic vertebrae of both species (Fig. 4-B and F).

Caudal Vertebrae

The anterior caudal vertebrae of *T. radix* (Fig. 5-E, F, G and H) number five or six in the specimens studied. In addition to their total number being essentially the same as in *P. catenifer*, they also develop a ridgelike hypapophysis (Fig. 5-E and F) on the first one or two vertebrae of this subregion, and rather rudimentary haemapophyses on the remaining three or four. The dorsal branch of the lymphapophysis does not arc as much ventrally in *T. radix* (Fig. 5-E and F), and the ventral branch does not attain as great a length proportionally, sweep back posteriorly, or curve as much ventrally at its apex. The neural spine is also narrower and projects more posteriorly (Fig. 5-H) in *T. radix*.

There are three or four vertebrae belonging to the middle caudal subregion in *T. radix* (Fig. 6-E, F, G and H), the same number as was found to be present in *P. catenifer*. These vertebrae are similar in the two species, but there are noticeable differences in their fixed ribs (transverse processes) and haemapophyses. In *T. radix* the fixed ribs curve posteroventrally (Fig. 6-G) instead of anteroventrally (Fig. 6-C) as they do in *P. catenifer*. The haemapophyses of this species are more delicate in structure, not as widely arched from each other at their midpoint (Fig. 6-E and F), and they project more posteriorly (Fig. 6-G and H) than in *P. catenifer*.

The vertebrae of the posterior cauda subregion of *T. radix* (Fig. 7-E, F and G) vary greatly in number from specimen to specimen just as in *P. catenifer;* however, an average would fall somewhere between fifty and sixty (an average of about five less than in *P. catenifer*). For the most part, the same interspecific differences found in the middle caudal vertebrae are carried over into the posterior subregion; however, the neural spine slopes more obliquely anteriorly (Fig. 7-G), and the transverse processes curve more anteriorly at their apices and are more pointed and less footlike (Fig. 7-G) in *T. radix*.

There were no noticeable differences in the ribs of the two species except for size. *Thamnophis radix*, being the smaller serpent, developed proportionately smaller ribs.

SKULL

The skulls of both species are composed of similar bones and bone structures; however, there are a few morphological and size relationship differences that do exist. The most apparent of these differences and those thought to be of some significance will be discussed. A dorsal view of the skull of *T. radix* (Fig. 8-B), a lateral view (Fig. 9-B), a ventral view (Fig. 10-B), and a posterior view of the cranium (Fig. 11-D) have been included to facilitate the comparative discussion.

The premaxilla of *T. radix* is more compressed dorsoventrally, having a distinct depression or fossa about midway along its dorsal surface (Fig. 9-B) in contrast to the ridgelike process in *P. catenifer* (Fig. 9-A). This posterodorsal process does not extend dorsally to wedge

between the anterior portions of the nasals as it does in *P. catenifer.*

The **septomaxillae** are heavier and more extensive in *T. radix.* They cover a greater proportion of the ventrally-attached vomers in this species, and the lateral winglike processes are proportionately broader and turn posterodorsally (Fig. 9-B) instead of anterodorsally (Fig. 9-A) as they do in *P. catenifer.* The elongate, flat anterior processes from the septomaxillae are less tapered and more horizontally situated in *T. radix.*

Although the **frontals** and **prefrontals** are more rigidly attached in *T. radix,* there are no significant differences in these bones in a comparison of the two species. The **parietal** and **postorbitals,** however, show a major structural modification in *T. radix.* The parietal is narrower proportionately, develops more prominent dorsolateral crests, and lacks the small, paired foramina on its dorsal surface (Fig. 8-B). In *P. catenifer* the parietal foramina (Fig. 8-A) are quite prominent.

In comparing the length of each parietal with its width, it was found that in *T. radix* the parietals were 1.1 times as wide as they were long, whereas in *P. catenifer* they were 1.3 times as broad as long.

The **postorbitals** of *T. radix* are not just narrow, elongate bones attached to the anterolateral margins of the parietals as they are in *P. catenifer* (Figs. 9-A, 11-C), but they extend ventrally, coming in contact with the dorsal surfaces of the anterior spatulate processes of the ectopterygoids (Figs. 9-B, 11-D).

Some of the less obvious differences of the bones comprising the braincase are the narrower **basisphenoid** (Fig. 10-B) in the case of *T. radix,* with its transverse processes more posteriorly situated and extending laterally (perpendicular to the midline) instead of obliquely and posterolaterally as in *P. catenifer* (Fig. 10-A). The posteroventral surface of this bone presents a convexity instead of a concavity as it does in *P. catenifer.* In *T. radix* the **prootics** have a prominent crest running longitudinally along their lateral borders just dorsal to the large prootic foramina. This crest is somewhat hidden by the lateral border of the supratemporal. The lateral process which projects posteriorly, partially obscuring the opening to the posterior prootic foramen, is not present in *T. radix.* Therefore, the foramen appears round, from a lateral view (Fig. 9-B), instead of kidney-shaped (Fig. 9-A) as in *P. catenifer.*

The **basioccipital** of *T. radix* develops a prominent, median, crestlike process or hypapophysis (Fig. 11-D) for the attachment of ventral neck muscles; this structure is not found on the basioccipital of *P. catenifer.*

From a dorsal view (Fig. 8) the size of the posteromesial notch in the dorsal surface of each **exoccipital,** where each sutures in the midline, is greater in the case of *T. radix* (Fig. 8-B).

Both the **quadrate** and the **supratemporal** are proportionately heavier and broader (Figs. 8-B, 9-B) in *T. radix.* They do, however, occupy approximately the same position in both species.

The **maxillae, ectopterygoids** and **palatines** (Fig. 10-A and B) are similar structurally in the two species, but there is a difference in the number of teeth on the tooth-bearing structures (maxillae and palatines). The maxillae of *T. radix* bear about twenty-two or twenty-three curved teeth as compared to the fifteen or sixteen in *P. catenifer;* the palatines bear about eighteen teeth as compared to the nine or ten teeth developed in *P. catenifer.* The large, flattened, median process of the palatine is directed more dorsally in *T. radix,* and in most cases the dorsal apex of this process arches mesially, terminating in a ventral direction.

The **pterygoids** (Fig. 10-A and B) are proportionately broader, their longitudinal ventral grooves deeper, and the number of teeth is greater in *T. radix.* This species bears about twenty-seven or twenty-eight teeth (more than twice as many as found in *P. catenifer*) in a longitudinal median row which extends almost twice as far posteriorly as it does in *P. catenifer.* The pterygoid is abruptly curved laterally at its posterior end, making the mandibular articulation in *T. radix;* whereas in *P. catenifer* the entire bone is gradually curved laterally until it articulates posteriorly with the angle of the jaw.

The **mandible** of *T. radix* is curved a little more mesially at its middle dentary articulation (Fig. 10-B), and it contains from twenty-eight to thirty teeth on the dentary portion, or about twice as many as previously recorded for *P. catenifer.* Both species have splenial and angular bones that can be separated from the anteromesial border of the proximal half of the jaw bone (Fig. 11-B).

Although the shape and structure of the **hyoid apparatus** (Fig. 11-A) is very similar in the two species, it is proportionately longer in *T. radix,* being approximately 2.2 times longer than its mandible. In *P. catenifer* the hyoid is only approximately 1.4 times longer than the

mandible. Both species, however, develop a rather large and functional hyoid apparatus. According to Albright and Nelson (1959), *Elaphe obsoleta* has a hyoid apparatus about twice the length of its skull.

Smith and Warner (1948) figured a series of ophidian hyobranchia and included the genus *Pituophis*, but not *Thamnophis*. Their Fig. 1-R of *Pituophis* is similar to our Fig. 11-A, but differs in that it is smoothly rounded anteriorly, whereas we find *Pituophis* to exhibit a small anterior protuberance which we have designated as the basihyobranchial. The specimens of *T. radix* used in this study, however, did not possess this anterior protuberance.

Although Cowan and Hick (1951) did not discuss the osteology of the hyoid apparatus of *Thamnophis sirtalis* as such, they indicated its structure by figures and descriptions concerning the hyoid musculature. According to these authors the basihyal (basihyobranchial) portion of the hyoid of *T. sirtalis* is smoothly rounded anteriorly, and does not possess an anterior protuberance.

DISCUSSION

From the foregoing comparisons it is evident that there are osteological differences existing in the two species. In order to provide a complete comparison of the differences it would be necessary to correlate and compare as many of these interspecific differences as possible with other serpent groups (particularly colubrids) in order to arrive at some osteological continuity in the species studied, and to postulate some reasons for these differences. This is obviously beyond the scope of this study. There are, however, a few osteological differences that can be discussed, and these will be considered insofar as our data will permit.

The ribless condition of the first thoracic vertebrae, as demonstrated by *P. catenifer* and *T. radix*, has not been reported in the species studied by the majority of workers (*op. cit.*). Owen (1866) stated that the ribs commence in the cobra, as they do in other serpents, at the third vertebra from the head. Kellicott (1898) mentioned short transverse processes in connection with the heads of the ribs as being present on all of the body vertebrae (not including atlas and axis) in *Heterodon*. A general statement was made by Gadow (1901) concerning snakes, in which he states that "all the vertebrae, except the atlas, carry ribs." Albright and Nelson (1959) reported short ribs on vertebrae 3 and 4 of *Elaphe*, the first full-length rib being on the fifth vertebra. Ludicke (1962), on the other hand, reported that all of the vertebrae, with the exception of the atlas, can bear free ribs, but the axis and the first two "cervical" or thoracic vertebrae may also lack ribs in some species. The latter statement appears to coincide more fully with the findings of our study in which the first thoracic vertebra was lacking free ribs.

Because of the close adherence of the atlas to the cranial elements and the difficulty involved in separating it from the skull intact, it may be that some of the above statements are not based on sufficiently meticulous dissection to be complete. Possibly the true atlas has been overlooked in some cases, and has not been included as part of the anterior vertebrae. A detailed study of many different genera would be necessary in order to determine the extent of the ribless first thoracic vertebrae in the various types of colubrid snakes.

The presence of metapophyses on the first thoracic vertebra of *P. catenifer*, along with their greater development on the other thoracic vertebrae, seems to indicate a more extensive area for the attachment of lateral trunk muscles, giving this constriction species an advantage in both strength and motility in the neck and anterior trunk region.

Thamnophis radix, being the smaller of the two species, has fewer precaudal vertebrae, but the proportionate number of the various types of vertebrae in this region vary in the two species (Table 1). There is a decrease of approximately 48 (26%) lumbar and 28 (29%) thoracic vertebrae in *T. radix* when compared to *P. catenifer*. It is evident from the above data that the larger snake (*P. catenifer*) owes much of its greater precaudal body length to the greater number of lumbar vertebrae, but proportionately or percentage-wise, there is an addition of about twice as many thoracic vertebrae as compared to the lumbar.

Owen (1866) stated that hypapophyses are developed on the first seventy-four of 253 body vertebrae in *Python tigris*, the first sixty anterior body vertebrae (305 total, counting caudals) in

Table 1. A comparison of the number of vertebrae in each of the vertebral regions and subregions of fourteen *Pituophis catenifer* and twelve *Thamnophis radix*. Both male and female specimens are included.

Vertebral Column Areas	Average Number of Vertebrae (Ranges in Parentheses) *P. catenifer*	*T. radix*
Atlas	1	1
Axis	1	1
First Thoracic	1	1
Other Thoracic	52	23
Lumbar	185	137
Anterior Caudal	6	6
Middle Caudal	4	4
Posterior Caudal	61	56
Precaudal	240 (237-244)	163 (160-165)
Caudal	69 (60-78)	64 (58-69)
Precaudal and Caudal	309 (297-322)	227 (218-234)

Boa constrictor, and from the thirty-two anterior vertebrae of *Dasypeltis scabra*, which has a total of 256 vertebrae. The anterior ten hypapophyses of this latter snake are directed posteriorly, whereas the posterior ten are pointed anteriorly. Owen also reported that all of the 168 body vertebrae of *Crotalus horridus* develop hypapophyses, and likewise, all of the body vertebrae in *Naja tripudians*. These hypapophyses, however, were found to be shorter in the more posteriorly located body vertebrae. *Heterodon*, however, possesses hypapophyses only on the first twenty-two of 135 body vertebrae (Kellicott, 1898).

From the few species mentioned above, it would appear that when using the presence or absence of hypapophyses as a criterion, *P. catenifer* is similar to the other constricting species such as *P. tigris* and *B. constrictor*. *Heterodon* and *D. scaber*, not being constrictors and yet lacking hypapophyses on the lumbar vertebrae, appear to contradict the highly speculative assumption above, or possibly one could infer that these snakes are closely related to the constrictor-type serpents. A much more intensive investigation including many different species of Colubridae would have to be made before such a hypothesis could be verified.

Although *P. catenifer* has an average of about five more caudal vertebrae than *T. radix* (Table 1), its tail is actually proportionately shorter because of the greater number of precaudal vertebrae. The ratio of precaudal vertebrae in *P. catenifer* is 3.5:1, that of *T. radix* being 2.5:1. Ludicke (1962) states that Colubridae and Elapidae have a ratio of precaudal to caudal vertebrae of 2:1. The two colubrid species involved in this study appear to have a higher proportion of body or precaudal vertebrae than the group of colubrids from which Ludicke's ratio was calculated. The added length in the tail region (proportionately) in *T. radix* over *P. catenifer* might be of some advantage to this semi-aquatic species when taking to the water.

According to Brongersma (1938) the characteristic of well-developed hypapophyses under the posterior precaudal vertebrae is a variable character in some species. Such species as *Chrysopelea ornata* (Shaw) and *Boiga irregularis* (Merr.), collected from the Indo-Australian Archipelago, the Philippines and Siam, were found to vary from specimen to specimen in the presence or absence of well-developed hypapophyses.

The presence of parietal foramina, in the case of *P. catenifer*, is a peculiar phenomenon if the statements made by some writers are to be interpreted rigidly. Kingsley (1917) and Williston (1925) stated that Ophidia lack parietal foramina. Gadow (1901) qualified his statement somewhat, and mentioned that there is no interparietal or pineal foramen in serpents. In dealing with *Elaphe*, Albright and Nelson (1959) found a small foramen in the posteroinferior surface of the parietal, and stated that it is the only one of any size in the entire wide expanse of the bone. We assume that their posteroinferior surface of the parietal is our posterior lateral or ventral surface. In none of their plates did they figure this foramen. According to Williston (1925) the parietals are always fused in serpents. Romer (1956) stated that parietals, as in most lizards, are fused into a single bone in nearly all snakes. The two species involved in this study demonstrate this fused parietal phenomenon; however, Mookerjee and Das (1932) recorded that distinct paired parietals were present in *Typhlops braminus*, and that perhaps this species had been overlooked by some previous writers.

The osseous connection between a cranial bone (postorbital) and the upper jaw structures, as found in *T. radix*, has less flexibility and is more rigid than the ligamentous connection in *P. catenifer*. Perhaps this structural rigidity is needed in the case of *T. radix* as it eats live, nonconstricted prey which would be struggling during the engulfing process. It should be mentioned, however, that *Python*, a constrictor, has a postorbital which contacts the ectopterygoid. The postorbitals of *Boa* and some poisonous serpents, according to Owen (1854), do not reach the ectopterygoids. Albright and Nelson (1959) indicate that in *Elaphe obsoleta* the small, nar-

row postorbitals approach but do not articulate with the upper jaw structures. Such an osseous connection is also lacking in *Heterodon*.

The proportionately heavier and broader quadrate and supratemporal in the case of *T. radix* seems to coincide with the previously stated conjecture concerning rigidity in the jaw structures necessary for the feeding habit of this species.

According to Kellicott (1898) the basioccipital hypapophysis, which is present in *T. radix* but missing in *P. catenifer*, is also lacking in *Heterodon*. Owen (1854) stated that the python has a prominent hypapophysis with a recurved point, and that the rattlesnake also develops a long, strong, recurved hypapophysis from its basioccipital which acts as a point of insertion for the powerful ventral neck muscles, by which the downward stroke of the head is performed in the act of inflicting a wound.

In both species studied, there were occasional specimens which demonstrated an abnormally large number of teeth on some of their toothed structures. It was noted that the bases of the extra teeth were lined up along the sides of the teeth in the normal tooth row, one tooth being firmly fixed in the socket, and the more medially placed tooth being only connected to the bone by fascia. It appeared as if the loosely connected teeth were being replaced by the firmly fixed ones, thus maintaining a complete set of functional teeth at all times. This observation, pertaining to the continual replacement of teeth in serpents, was noted in the works of West (1898), Kingsley (1917), Wiedersheim and Parker (1907), Gadow (1901), and more recently by Edmund (1960), to mention a few. Almost all reptiles are polyphyodont (number of dentitions indefinite), but in some cases such as Typhlopidae, certain teeth are not replaced and others undergo reduction (Wiedersheim and Parker, 1907).

The greater number of teeth found on all of the tooth-bearing structures in *T. radix* (Table 2) seems to give this species an advantage in grasping and retaining struggling prey such as frogs, toads, fish, grasshoppers, mammals, and other regularly eaten animals. This adaptation to the nonconstrictor habit of food-getting was noted previously in connection with the postorbitals, quadrates, and supratemporals.

The proportionately narrower posterior portion of the skull, due mainly to the narrower parietal, has possibly resulted from selection for more streamlined forms, in the case of *T. radix*, which would have an advantage for life in the swampy areas where diving and swimming become an integral part of its life.

Table 2. A comparison of the number of teeth developed on the various tooth-bearing structures of fourteen *Pituophis catenifer* and twelve *Thamnophis radix*.

Tooth-bearing Structures	Average Number of Teeth (Ranges in Parentheses)	
	P. catenifer	*T. radix*
Maxilla	15 (14-17)	23 (22-25)
Palatine	9 (8-11)	18 (16-19)
Pterygoid	10 (8-12)	28 (26-29)
Mandible	18 (15-20)	28 (26-30)

SUMMARY AND CONCLUSIONS

The complete skeletal anatomy of *Pituophis catenifer deserticola* Stejneger is described in detail. The osteology of this species is compared with that of *Thamnophis radix haydeni* Kennicott in the following areas: atlas, axis, first thoracic, other thoracic lumbar, anterior caudal, middle caudal, and posterior caudal vertebrae, as well as the skull and hyoid apparatus.

Many structural similarities exist in these two species of colubrids. The more important structures or aspects in which similarities were observed are: (1) the natural division of the vertebral column into regions and subregions, (2) the gross morphology of the various types of vertebrae, (3) the number and types of bones comprising the skull, (4) the number and location of the majority of vertebral and skull foramina, (5) the structure of the hyoid apparatus and the ribs, and (6) the position and shape of the stapes.

The major structures or aspects in which there are differences encountered between the two species are: (1) the shape of the anterior hypapophysis of the atlas, (2) the existence or lack of metapophyses on the first thoracic vertebra, (3) the presence or absence of hypapophyses on the lumbar vertebrae, (4) the relative size and shape of the lymphapophyses, (5) the structure of the caudal haemapophyses, (6) the number of vertebrae in each region and subregion, (7) the relative size and shape of the

cranium and its component bones, (8) the shape and character of the septomaxillary process, (9) the existence or lack of paired parietal foramina, (10) the shape and extent of the postorbitals, (11) the presence or absence of basioccipital hypapophyses, (12) the number of maxillary, pterygoid, and mandibular teeth, (13) the relative size and character of the supratemporal, quadrate, and mandible, and (14) the relative size of the hyoid apparatus.

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ABBREVIATIONS USED IN PLATES

VERTEBRAE

A.HYP.	anterior hypapophysis.
A.INT.F.	anterior intercentral facet.
A.NEU.F.	anterior neurapophysial facet.
CEN.	centrum.
CO.PR.	costal process.
D.CR.	dorsal crest.
F.RB.	fixed rib.
HAEM.	haemapophysis.
HYP.	hypapophysis.
HYP.F.	hypapophysial facet.
INT.	intercentrum.

LP.D.B.	lymphapophysis dorsal branch.
LP.V.B.	lymphapophysis ventral branch.
MET.	metapophysis.
N.C.S.	neuro-central suture.
NEU.	neurapophysis.
N.S.	neural spine.
N.SU.	neural suture.
O.CL.	odontoid canal.
O.PR.	odontoid process.
PARP.	parapophysis.
P.HYP.	posterior hypapophysis.
P.INT.F.	posterior intercentral facet.
POZ.	postzygapophysis.
POZ.F.	postzygapophysial facet.
PRZ.	prezygapophysis.
PRZ.F.	prezygapophysial facet.
RB.F.	rib facet.
RB.H.	rib head.
SH.	shaft.
T.PR.	transverse process.
ZE.	zygosphene.
ZE.F.	zygosphenal facet.
ZM.	zygantrum.
ZM.F.	zygantral facet.

SKULL

A.	angular.
AR.	articular.
BH.	basihyobranchial.
BO.	basioccipital.
BO.HYP.	basioccipital hypapophysis.
BO.T.PR.	basioccipital transverse process.
BR.COR.	branchial cornu.
B.S.	basisphenoid.
D.	dentary.
D.F.	dental foramen.
EC.	ectopterygoid.
EO.	exoccipital.
FO.M.	foramen magnum.
FOV.	foramen (fenestra) ovalis.
FR.	frontal.
J.F.	jugular foramen.
M.	maxilla.
ME.F.	mechelian foramen, canal or groove.
NAS.	nasal.
O.C.	occipital condyle.
OP.F.	optic foramen.
OT.C.	otic capsule.
PAL.	palatine.
PAR.	parietal.
PARA.	parasphenoid.
PAR.F.	parietal foramen.
PFR.	prefrontal.
PM.	premaxilla.
PO.	postorbital.
PR.	prootic.
PRA.	prearticular.
PT.	pterygoid.
QU.	quadrate.
SA.	surangular.
SM.	septomaxilla.
SM.PR.	septomaxillary process.
SOC.	supraoccipital.
SP.	splenial.
ST.	stapes.
SUP.	supratemporal.
VO.	vomer.
V.	fifth cranial nerve.

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MALE SPHAEROPTHALMINE MUTILLID WASPS OF THE NEVADA TEST SITE

by

WILLIAM E. FERGUSON

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MALE SPHAEROPTHALMINE MUTILLID WASPS OF THE NEVADA TEST SITE[1]

by

William E. Ferguson[2]

INTRODUCTION

In 1959, ecological studies of the fauna at the Nevada Test Site were begun by Drs. Dorald M. Allred and D Elden Beck of the Department of Zoology and Entomology, Brigham Young University[3]. In 1962 I was asked to identify the mutillid wasps which had been taken in large numbers, chiefly from can pit-traps (Fig. 1) that had been in place at the same localities for several years. However, only the females of nocturnal species were well represented. In August, 1964, I was invited to study the mutillid fauna at the test site, and collect the males of the species. The females remain largely unstudied, unnamed, and have been grouped as one genus, although the males are much better known and are separable into several genera. Only three published accounts of sex correlations among the nocturnal mutillids appear in the literature.

Fig. 1. Can pit-trap with open end flush with the ground surface. Masonite cover is raised out of position at left.

It was assumed that with the large numbers of females at hand, the sexes of the species could be correlated in spite of the great sexual dimorphism.

Attempts to correlate the sexes at the test site were unsuccessful. Possible reasons are as follows: (1) The apterous females were collected between 1959 and 1962, but most of the males were taken only in August, 1964, under different ecological conditions and by different collection methods, even though attempts to collect them were made at other times of the year. (2) Cycles of abundance are known to change considerably over the years (Ferguson, 1962). (3) Light traps are highly selective for males, and attract them from large areas. (4) Can pit-traps are nonattractive to females and males, but since the females must travel on the ground, they are more liable to find the covered traps by chance, and fall into the cans. (5) Males can fly out of the cans, whereas the females cannot escape. (6) Males which fall into the cans are more likely to be eaten by lizards and arthropods also caught in the traps, since the male mutillids are more active, less heavily sclerotized, and in contrast to the females, cannot sting. The best method of associating the males and females at the test site apparently must involve a thorough study of females from areas outside of the test site. Through study of the distributional patterns of the females, it may be possible to correlate them with males by a process of elimination based on geographical occurrence. The large number of unnamed females must be described, and all named females must be redescribed. This will be a considerable task that may take several years, and naturally is not within the scope of the present study.

Although the diurnal mutillids in this study are rather well known, even the males of nocturnal species are poorly known taxonomically

[1]B.Y.U.-A.E.C. Report No. COO-1326-4. Field work related to this study was done under A.E.C. contracts AT(11-1)786 and AT (11-1)1326 awarded to Brigham Young University. Study of the five species of *Sphaeropthalma*, subgenus *Photopsis*, reported herein, was greatly aided by N.S.F. Grant GB-2745 to the author, for "A Biosystematic Study of Nocturnal Mutillid Wasps in the Subgenus *Photopsis* of North America."

[2]Associate Professor of Entomology, Department of Biological Sciences, San Jose State College, San Jose, California, 95114

[3]For a detailed discussion on the ecology of the test site, refer to Allred, Beck, and Jorgensen (1963a, 1963b).

and distributionally. This study not only makes known the sphaeropthalmine Mutillidae of the test site, but contributes importantly to our knowledge of the taxonomy and distribution of the nocturnal Mutillidae. Furthermore, it has shown that even the former "ground zeros" of nuclear detonations are reoccupied by the mutillids within a few years following a blast or series of blasts. The barren area surrounding ground zero apparently is attractive as a nesting site for various species of flying aculeate Hymenoptera, which become hosts of the parasitic mutillids. The host species may find food for provisioning their brood cells in the soil, either inside or outside of the barren area. The flightless female mutillids then have reinvaded the barren area in one or both of the following ways: (1) by walking from the undevastated perimeter back into the barren area, or (2) by surviving nuclear blasts while in nests of their hosts deep in the soil, and emerging into the devastated area after the blast. There is interest as to whether or not nuclear testing will cause genetic abnormalities that will result in deformation, "monsters," and other unusual genetic traits. A careful search was made for such anatomical changes among the Mutillidae collected at the test site. Apparently the Mutillidae are not anatomically different from those outside of the test site. An organism's genetic adjustment to its environment is like an accurately adjusted chronometer. Anything that happens to that adjustment will most likely be deleterious. Hence, one would expect that genetic changes in creatures of the harsh desert environment would prove fatal in an extremely high percentage of instances. Abnormalities (unfavorable genetic traits) should neither survive nor spread commonly throughout a normal, surrounding population. This appears to be true of the mutillid population samples, if such genetic aberrations have occurred.

ECOLOGY OF THE TEST SITE

The Nevada Test Site of the Atomic Energy Commission is located in southern Nye County, Nevada, at elevations from approximately 2800 ft, at Fortymile Wash, to 7694 ft on Rainier Mesa. The vegetation ranges from halophytes typical of the Mojave Desert playa margins, to the open stands of *Pinus monophylla* and *Artemisia tridentata* at higher elevations. The area is especially interesting because the boundary of the Mojave and Great Basin Deserts cuts in an east-west direction through the test site near its middle. More detailed discussions of the ecology of the test site were prepared by Allred, *et al.* (1963a, 1963b).

MATERIALS AND METHODS

Specimens from the test site were collected principally in sheltered can pit-traps in the soil (Fig. 1) and from light-traps of three kinds: (1) a 200-watt incandescent bulb suspended from a tripod above a ground-level, white cloth sheet; (2) a one- or two-mantle Coleman gasoline lantern above a white sheet or water-filled trap (Fig. 2); and (3) an ultraviolet light source (Fig. 3). Gasoline lanterns and ultraviolet lights appear to be equally effective in attracting mutillid wasps. The use of lights above sheets permitted hand-catching of the mutillids which were attracted to the lights. These were placed separately into cyanide killing jars, thus avoiding the disadvantage of moth scales and damage by other insects as is typical of most light traps. Specimens were returned to the laboratory and pinned before drying, and the genitalia were extruded.

Ultraviolet and incandescent light-traps were operated all or part of the night. Insects of many kinds were caught as they fell into detergent water beneath the light sources. The detergent used was American Cyanamid's Aerosol-OT. However, most other detergents were almost equally effective in reducing surface tension, thus permitting the insects to "drown" quickly, rather than struggle on the water surface. The insects apparently were immobilized by the greatly reduced oxygen supply in the water, but after submergence during the night, most of the insects became active again within a few minutes to several hours after removal from the water. The nocturnal mutillids were

Fig. 2. Gasoline lantern light-trap. A large aluminum salad-ring mold is buried with its edge flush with the ground surface, and is filled with detergent water. The lantern covers the center hole and provides light all night.

Fig. 3. Generator-operated, 40-watt ultraviolet light-trap supported on folding wooden legs. The shallow depression beneath was formed with a shovel, lined with a plastic sheet, and filled with detergent water.

washed individually in clean detergent water, rinsed for a few minutes in 70% and 90% ethyl alcohol, dried briefly on a paper towel, and pinned. This procedure prevented matting of the pubescence and wings, especially when the pinned specimen was blown upon with a strong air stream from the lips. The unattended, all-night light-traps were especially effective for trapping the small, hard-to-catch individuals, for collecting a series of a common species, and for catching individuals of species which were present in low densities.

Although females are positively phototaxic at night, few were attracted into the light-traps. Probably this was due to ground-level shadows of surface irregularities and plants, and to low mobility of the females.

Can pit-traps were outstandingly effective in trapping female mutillids, but either were much less effective in trapping males, or allowed them to escape after entering the traps. Specimens from can pit-traps had been preserved in alcohol, which is unsuitable for mutillids. Furthermore, some of the vials lost alcohol through their cork stoppers, thus concentrating the glue-like dissolved body fluids and dirt. All alcoholic specimens required washing in 70% and 90% ethyl alcohol, and ether, prior to pinning and identification. Nevertheless, some could not be restored adequately for certain identification because of altered integumental color, matted hairs and wings, and insoluble "glue" and dirt on the integument.

Each specimen was assigned a reference number and a code number, both of which relate to collection records.

Because of inadequate knowledge of female behavior, it is impossible at the present time to determine the influences of certain ecological factors on the two sexes. However, during the light-trapping in August, 1964, surface activity of the males was greatly reduced or even stopped by bright moonlight, rain, strong winds, or low temperature. Nocturnal temperatures in the range 80° to 100° F apparently are optimum for the flight of the males, but activity was noticeably reduced in the range of 70° to 80° F, and was insignificant below that temperature range.

Distribution records for the test site are fragmentary and are localized because of preplanned, intensive collections in selected areas, especially those closer to headquarters at Mercury, and adjacent to roads. More informative can pit-trap and light-trap survey data for the Mutillidae should include replicated transects between altitude extremes and in the same vegetation types at comparable sampling stations. All-night, gasoline lantern, detergent-water light-traps operated once or twice each week would catch males and some females, but permanently installed can pit-traps for females could be operated continuously at each station. Such a sampling method would provide much more trustworthy information on sex associations and relative abundance.

Specimens on which this study is based came primarily from Frenchman Flat and the hillsides north-northwest of Mercury. Locality 1B, in Yucca Flat, and Cane Springs were secondary collection sites, and collections from the higher valley slopes and top of Rainier Mesa were relatively few. Figure 4 will assist in locating the areas referred to in this paper. For more exact collection code interpretation, refer to Allred, *et al.* (1963b).

The light-trap collections of nocturnal male mutillids were limited at the test site, but several factors permit making generalizations about the distribution of species there. First, maximum and minimum temperatures, which were recorded for several years at a number of localities at the test site, indicate that August is the most favorable time for nocturnal activity of mutillids. Consequently, one can expect the largest numbers of individuals and species to be active during that month, when most of the light-trapping was done. Furthermore, I have collected extensively to the north of the test site in the Great Basin Desert, and to the south in the Sonoran Desert. Collections from these two deserts have been compared with each other, with smaller collections from the Mojave Desert, and with collections from the test site, as a basis for speculating or generalizing about the occurrence of mutillids at the test site. These speculations must not be confused by the reader with the presently known facts of distribution, which are simply the raw collection data.

HISTORICAL REVIEW

Prior to 1958, the classification of nocturnal Mutillidae and the description of species were based largely upon morphological characters which today are not recognized as reliable indicators of phylogenetic relationship. Schuster's important paper was published in 1958, but had been written approximately twelve years earlier. It included many new, very distinct species, focused attention on newly discovered taxonomic characters, and included a new classification. However, several characteristics of his work have impeded rapid improvement of our taxonomic concepts and classification of the nocturnal Mutillidae. These impediments include (1) validation of most specific names only in keys rather than in adequate descriptions, (2) lack of precise type locality or distribution data, (3) lack of information on the range of variability of each species, (4) lack of designated holotype specimens for many names, and (5) apparent

Key to the important collection localities shown in Fig. 4.

1. Mercury—incandescent and ultraviolet light collections
2. Hillside 0.8 mi NNW of Mercury—incandescent and ultraviolet light
3. 10S study area—can pit-traps
4. ½ mi E of Mercury Hwy. on Kay Bunker Rd.—light collections
5. Cane Springs—can pit-traps and light collections
6. 0.3 mi W of Y on Rainier Mesa—light collections
7. Rainier Mesa Rd. at ponds near Tunnel E—light colections
8. 1 mi W of Y on Rainier Mesa—light collections
9. 0.9 mi W of Area 12 residences—light collections
10. 3 mi SSW of Area 12 residences on new road to Fortymile Canyon—light collection
11. 1B study site—can pit-traps, one light collection at 1BB25
12. 0.2 mi E of Mercury Hwy. at Checkpoint Pass—light collection
13. Old Mercury Hwy., 1 mi from Mercury Hwy., at 3400 ft (extreme NE corner of Specter Range Quadrangle)—light collection
14. 5A study area—can pit-traps and light collections
15. Old Mercury Hwy. in barren, extensive sandy wash, 2 mi from intersection with Mercury Hwy. in Frenchman Flat—light collection
16. 5E study area—can pit-traps and light collections
17. 4A study area—can pit-traps
18. ECB study area—ultraviolet light collections
19. CP study area—Allred live-catch, box-type traps
20. 6A study area—can pit-traps
21. 1F study area—can pit-traps

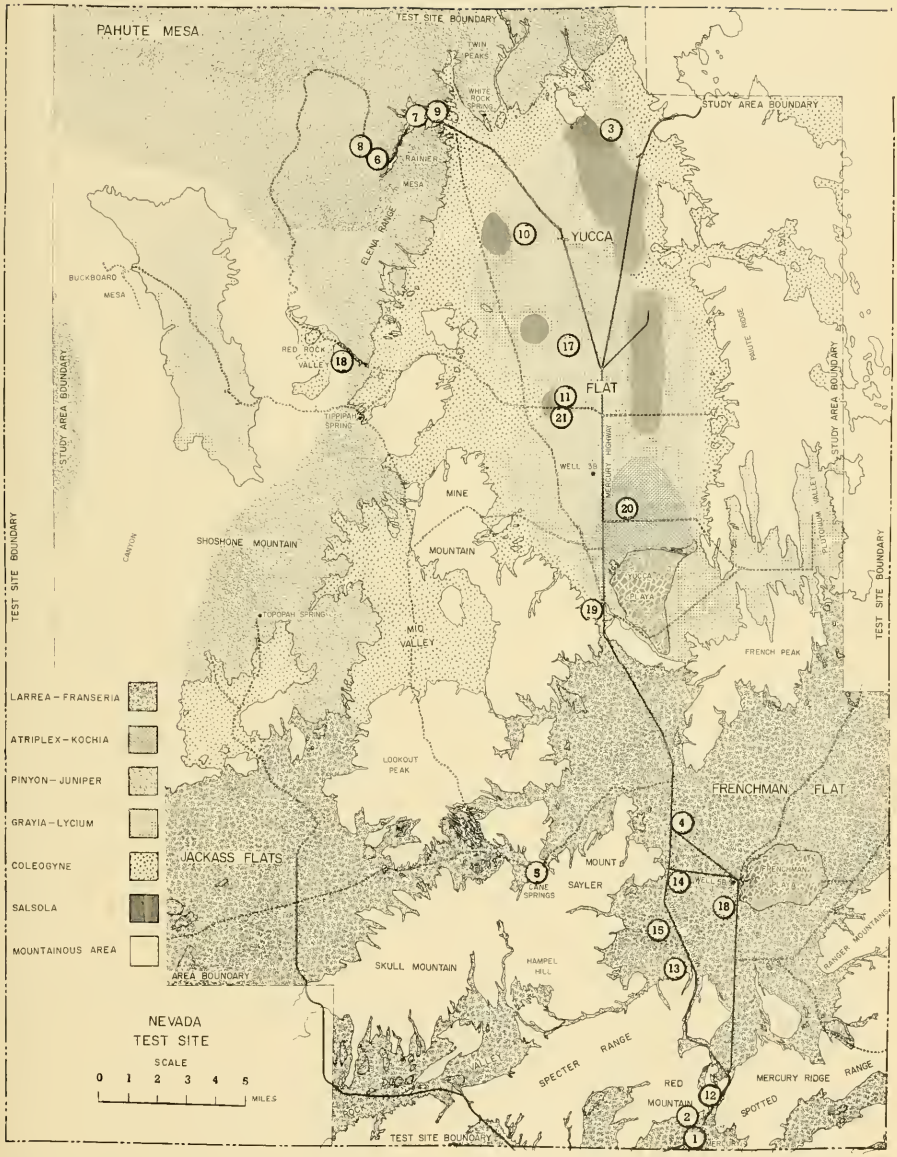

Fig. 4. Principal collection sites of mutillid wasps at the Nevada Test Site. See key on facing page.

loss of some holotypes and lack of information about locations of many others.

In July, 1959, one year after publication and approximately thirteen years after preparing the first manuscript, Schuster attempted to find and label type specimens representing the names that he had validated in his keys. Some were found and deposited in major repositories, some were not found, whereas others apparently remain in the Schuster collection although they are the property of institutions from which they were borrowed many years ago.

Because Schuster largely neglected publication of type data, it is included here, when known, for all species. Missing type specimens, inaccessibility of others, and unpublished type data have affected this study in several ways: (1) inability to verify the accuracy of some steps in Schuster's key leaves identification of a few species in question, (2) a few specimens from the test site have been retained by me without identification because they represent undescribed or inadequately described species, and type material is unavailable for comparison.

MORPHOLOGICAL CHARACTERS

Certain terminology and measurements used by Schuster have never been adequately explained; hence, I have included herein my interpretation of these, and an alteration of some other aspects of his terminology.

Measurements are most meaningful to mutillid taxonomists when expressed in units rather than in a ratio or other expression. The taxonomist must be able to judge the accuracy of measurement when necessary, and construct whatever ratios may be desirable from the unaltered measurements. Consequently, in descriptions of new species I have given most measurements in ocular micrometer units, which equal one-sixtieth of a millimeter. The limits of accuracy in using my ocular micrometer at 60x magnification are plus or minus one-half unit. Measurements on small individuals, therefore, are subject to relatively greater error.

Relative to pubescence, I have used the term **simple hair** to describe hairs which have smooth rather than barbed surfaces. **Brachyplumose** refers to hairs which have many barbs, the lengths of which are approximately equal to or less than the diameter of the hair at the place where each barb is located. **Plumose** is reserved for hairs which have longer barbs on at least part of their length.

Body size is variable and dependent on the amount of food available to the mutillid larva (Ferguson, 1962). **Sculpture** is most regularly and deeply expressed in large specimens, but becomes more irregular and less distinct among the smallest individuals of a species.

Directions of structures on the head have traditionally been expressed as though the mutillid head were prognathous. Since the head actually is hypognathous, I have given directions on the head accordingly, and hope that this practice will be followed in future studies of the nocturnal Mutillidae.

Head shape has been described variously by Schuster, including "evenly semicircular behind the eyes," "temples bulging," "subquadrate," and others. In many cases, species which according to Schuster have the head other than "evenly semicircular" actually have the head outline, dorsal to the eyes, conforming almost exactly to an arc of a circle, rather than as described in one of the above phrases which indicates otherwise. Head shape can be determined precisely by drawing the head outline, in frontal view, with the aid of an ocular grid or camera lucida. On the basis of the height and width of the head above the eyes, one can determine geometrically the center of an arc with those proportions, and trace a true arc with a compass, over the head outline. I have done this with type specimens and have shown elsewhere in this paper that Schuster has imperfectly described head shapes of some species. The interpretation "subquadrate" probably is an illusion, at least sometimes, based on large head size, which results in relatively longer radius curvature, but not the subquadrate condition.

Eye length, as used here, includes measurement of the eye to the margin of the ocular sclerite, which is larger than the black area beneath it.

Ocellar length is the measurement of the greatest dimension of the ocellus.

Ocellocular distance is interpreted here as the shortest distance from the margin of the ocellus, to the margin of the ocular sclerite, but not to the margin of the black eye pigments.

New terminology also is introduced here for the **mandibular teeth.** Usually the mandibles are tridentate apically, as in Figures 5, 6, and 7. The apical tooth, which is an extension of the posterior margin (**ventral margin** of Schuster), is termed here the 1°, or primary tooth. The tooth which is an extension of the anterior margin (**dorsal margin** of Schuster) is termed the 3°, or tertiary tooth. The smallest, often extremely small tooth between, is termed the 2°, or secondary tooth. The mandibular tooth which often is found near the midpoint of the posterior margin and basad of a reduction in mandible width (**excision** of Schuster), is here considered the **basal tooth of the posterior margin** (as opposed to the apical teeth).

Thorax is used here as Mickel has used it, to include both the true thorax and the propodeum, and apparently is synonymous with Schuster's term **alitrunk.**

The **pterostigmal cell length** is measured from its separation at vein R + M + Sc, to its proximal margin, but not including the vein which encloses it distally. **Marginal cell length on the costa** is measured on the costal margin between the points where the enclosing veins bend most definitely toward the posterior margin, but none of the posteriorly directed veins is included in the measurement.

The **abdominal segments** are numbered as in other literature on Mutillidae, with the petiole or morphological second segment considered the first abdominal segment, and the first segment of the gaster considered the second abdominal segment. The **length of the second abdominal tergum** is measured through the midline of the felt line.

Penis valves, as defined by Michener (1944), are the paired structures between which the membranous **endophallus** issues apically. The pair is clasped laterally by **parapenal lobes** of the **parameral plates.** From the latter, the **parameres** extend apicad, and the **cuspes** are parallel to and between these, but are separated from each other basally by the penis valves.

The coarseness of the punctation depends on the diameter and depth of individual punctures in relation to the size of the punctured sclerite. In this paper, the following terms express the degrees of punctation in the order of decreasing coarseness: reticulate, coarse, moderate, small, fine, micropunctate. The latter refers to punctures which are smallest of all, extremely shallow, and do not have vertical walls or sharp margins.

There is a definite need for revision and modernization of mutillid terminology, as well as alteration of the description format, now that our nocturnal mutillid fauna is relatively much better known.

ACKNOWLEDGMENTS

I wish to thank Drs. D Elden Beck and Dorald M. Allred of Brigham Young University who made this study possible. Clive D. Jorgensen, field director for some of the B.Y.U. projects at the test site, was directly responsible for coordinating on-site activities. Mr. Clyde Pritchet, Research Associate, was especially helpful in providing technical assistance. I am also grateful to the following who facilitated the study of type specimens in their care: Drs. Harry Allen and the late Harold J. Grant, Jr., Academy of Natural Sciences at Philadelphia; Dr. K. C. Kim, University of Minnesota; Dr. Karl V. Krombein, U.S. National Museum; Mr. Hugh B. Leech, California Academy of Sciences; Dr. W. R. M. Mason, Canadian National Collection; and Dr. Clarence E. Mickel, Tucson, Arizona. Of special significance was my opportunity to study some type specimens as a part of the Brigham Young University cooperative study.

I acknowledge here the loan and ownership, by the following persons and institutions, of specimens involved in this study. The following abbreviations are used throughout the text: AMNH, American Museum of Natural History; ANSP, Academy of Natural Sciences at Philadelphia; BM, British Museum (Natural History); BYU-AEC, Brigham Young University-Atomic Energy Commission Projects; CAS, California Academy of Sciences; CDA, California Department of Agriculture; CIS, California Insect Survey, University of California at Berkeley; CNC, Canadian National Collection; CU, Cornell University; DAG, D. A. Garner; JZW, J. Z. Warren; LACM, Los Angeles County Museum; OSU, Ohio State University; RMS, R. M. Schuster; TAM, Texas Agricultural and Mechanical College; UA, University of Arizona; UCD, University of California at Davis; UCR, University of California at Riverside; UI, University of Idaho;

UM, University of Minnesota; USNM, United States National Museum; USU, Utah State University; UU, University of Utah, and WEF, William E. Ferguson. All other records not designated by the above initials were taken as part of the Brigham Young University study at the Nevada Test Site.

I am especially grateful to my wife, Stephenie, for her assistance in preparing the manuscript.

SPECIES ACCOUNTS

In the treatments of new species of male mutillids, I have departed from the usual format used for descriptions of the diurnal species. As new taxonomic characters are discovered and other characters are considered to be of little importance, species concepts change. Consequently the nature of the descriptions has changed and will continue to change.

Coloration of the diurnal species often is helpful in identification, but in the nocturnal species it is much more uniform, and therefore much less useful for identification with the unaided eye. Since one must use the microscope to begin identification of the nocturnal forms, even to genus, the taxonomist is aided most by having the key morphological characters mentioned in the diagnosis of each species. In order to keep the diagnosis of males brief yet meaningful, I have included descriptions of certain features of the following: (1) size, (2) mandibles, (3) clypeus, (4) mesosternal tubercles or processes, (5) processes of the coxae and trochanters, and (6) felt lines. The genitalia usually are of great importance taxonomically, but since the description of these structures appears last in each species description, the information is found there easily.

In the lists of type data, a specimen that is not definitely known to be a holotype, as distinguished from lectotype or syntype, is listed thus: holotype (?).

Acrophotopsis curygnathus Schuster

Acrophotopsis eurygnathus Schuster, 1958. Entomol. Amer., 37(n.s.):10, 68.

Type data. Holotype ♂ Globe, Arizona (CAS). Paratopotypes: 2 ♂ same data as holotype. Paratypes: 44 ♂ (see Schuster, 1958:68).

Discussion. Nineteen specimens were taken in June, July, and August in both can and lighttraps from only two localities at the test site: between Mercury Highway and the Frenchman Flat playa (about 3200 ft), and at the Cane Springs area (4000 ft). Both of these localities are in the Larrea-Franseria biotic communinty (Allred, *et al.*, 1963a). These are the first records of occurrence in the Mojave Desert, and probably represent the northern limit of the species. Other published and unpublished records indicate that *eurygnathus* occurs in the Sonoran Desert of Arizona, but apparently not in the Great Basin Desert.

Dilophotopsis concolor crassa (Viereck), new combination

Odontophotopsis crassus Viereck, 1924. Canadian Entomol., 56:112.

Dilophotopsis concolor utahensis Schuster, 1958. Entomol. Amer., 37(n.s.):87. New synonymy.

Type data. *Odontophotopsis crassus,* holotype ♂ Oliver, British Columbia, Canada (CNC type no. 754). *Dilophotopsis concolor utahensis,* holotype ♂ Delle, Tooele Co., Utah (CU). Paratype ♂ Wadsworth, Storey Co., Nevada (erroneously published as New Mexico, where no such county exists). Although stated in publication that the holotype belongs in the Cornell University collection, it probably is still in the Schuster collection. The new synonymy listed above is based on examination of the holotype of *O. crassus,* which is typical of this Great Basin Desert form, and readily keys to *D. concolor utahensis* in the key by Schuster (1958).

Discussion. One specimen without darkened gaster was taken at study site 6A about 2 mi north Yucca Playa, and 0.6 mi east Mercury Highway (4000 ft).

I have taken this subspecies commonly in all of the Great Basin Desert states. It is significant, therefore, that *crassa* occurs extremely rarely at the test site, and the single collection locality is within the Great Basin Desert portion. *Dilophotopsis concolor paron* (Cameron) is almost equally rare, and apparently does not occur outside of the Mojave Desert portion. These are the distributional relationships one would expect based on collections that have

been made to the north and south of the test site.

Dilophotopsis concolor paron
(Cameron)

Sphaerophthalma [sic] *paron* Cameron, 1896. Biol. Centrali-Amer., Insecta, Hymenoptera, 2:381.

Dilophotopsis concolor sonorensis Schuster, 1958. Entomol. Amer., 37(n.s.):88.

Dilophotopsis concolor paron Mickel, 1965. Proc. Entomol. Soc. Wash., 67(1):1.

Type data. *Sphaerophthalma paron,* holotype ♂ (BM). *Dilophotopsis concolor sonorensis,* holotype ♂ Gila Bend, Arizona (UM). Paratype ♂ Chiricahua Mts., Arizona (depository unknown).

Discussion. This subspecies is represented at the test site by three specimens taken near porch lights on the CETO[4] laboratory building at Mercury (3800 ft). Apparently it does not even occur at lower elevations in Frenchman Flat. This form with the darkened gaster is characteristic of the Sonoran Desert, and this is the first published record of its occurrence in the Mojave Desert.

Acanthophotopsis falciformis falciformis
Schuster

Acanthophotopsis falciformis falciformis Schuster, 1958. Entomol. Amer., 37(n.s.):13, 108.

Type data. Holotype ♂ Palm Springs, California (UM). Paratypes: 2 ♂ Palm Springs, California (one at UM, location of other unknown); 1 ♂ 15 mi E Sombrerete, Mexico (depository unknown).

Discussion. Of the seven specimens taken at the test site, three were attracted to porch lights on the CETO building at Mercury (3800 ft) in August. At locality 5A (3200 ft) in Frenchman Flat, two came to ultraviolet light and one to incandescent light in August, but a fourth specimen was taken from a can pit-trap in June.

No records are known to me for the Great Basin Desert. Earlier published records include only the type series.

Sphaeropthalma (Micromutilla) acontia
(Fox)

Photopsis nanus Ashmead, 1896. Trans. Amer. Entomol. Soc., 23:181. Preoccupied.

Mutilla acontius Fox, 1899. Trans. Amer. Entomol. Soc., 25:266.

Mutilla Ashmeadii Fox, 1899. Trans. Amer. Entomol. Soc., 25:289. New name for *P. nanus* Ashmead. New synonymy.

Type data. *Photopsis nanus,* holotype ♂ Tucson, Arizona (USNM type no. 3279). *Mutilla acontius,* holotype ♂ Las Cruces, New Mexico (ANSP type no. 4644).

Discussion. Twenty specimens of this small-sized species were taken in both incandescent and ultraviolet lights in the Mojave Desert portions of the test site in late July and August. Specific localities include only Mercury, Cane Springs, and Rock Valley.

Individuals of this species are among the smallest nocturnal male Mutillidae in North America, averaging 5 mm in length. Consequently they are inconspicuous and usually are not captured unless a special effort is made to catch the smallest mutillids flying among the other insects around a light source. With such effort I collected 17 specimens in one month, whereas other collectors at the test site routinely collected only five in a period of about five years.

New synonymy is based on personal examination of the two type specimens. The genitalia of *acontia* are like those of *S. (Micromutilla) pallida* (Blake), and are unmistakably distinct from those of all other small nocturnal Mutillidae known to me. The cuspis is very short, scarcely extending beyond the tip of the penis valves. This character, coupled with the scarcely excised mandibles, relatively slender petiole, and parameres not apically divergent, facilitates identification of the species regardless of slight differences in size and sculpture.

The only reliable records of the distribution of *acontia* include the type localities of Tucson, Arizona, and Las Cruces, New Mexico. La Cueva, New Mexico (5300 ft) was cited by Melander (1903:318) as a collection locality; however, the altitude probably is too high for *acontia,* and Melander's mention of long pubescence suggests that some other, hairier species was misidentified.

Sphaeropthalma (Micromutilla) becki,
new species

Diagnosis. Male: Length 7 mm. Integument of antennae and body testaceous, legs slightly lighter. Mandibles with posterior margin excised to apex, reducing width of apical one-half to ap-

[4]Civil Effects Test Operations of the U.S. Atomic Energy Commission.

proximately one-half of basal width, with subtending tooth angulate and without a deep, rounded notch distally. Clypeal disc longitudinally concave near apical margin, transversely straight, with a pair of blunt, short teeth apically, basally not produced into a carina or tubercle. Mesosternum moderately, shallowly punctate, without tubercles or processes. Coxae and trochanters unarmed. Sternal felt lines subequal in length to those on second tergum. Pygidium polished, very shallowly micropunctate on apical one-fourth.

Description. Head: Integument polished, with outline dorsad of eyes forming an arc of a circle in frontal view; punctures fine, sparse. Measurements in micrometer units: eye length 39, ocellocular distance 17, ocellar length 15. Interocellar area darkened. Mandibles overlap dorsoventrally, anterior margin of distal one-half not twisted dorsad; bearing a distinct carina from base to tertiary apical tooth (Fig. 5). Apical mandibular teeth with 1° tooth basal

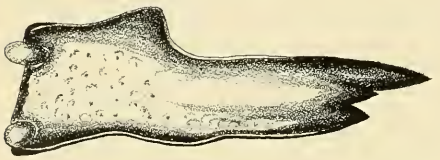

Fig. 5. Mandible of *Sphaeropthalma* (*Micromutilla*) *becki*.

width 1x and length 2x the 3° tooth; 2° tooth basal width ½x the 3° tooth. Clypeal surface polished, with sparse micropunctures bearing long or short simple hairs; apex not impressed below anterior margin of mandibles. Antenna with first flagellar segment short, 0.6x length of second segment. Frontal line and preocellar pit distinct. **Thorax:** Pronotum dorsally and laterally shallowly reticulopunctate, except polished and shallowly rugose on posterolateral margin. Mesonotal punctures fine, shallow, one puncture width apart, with flat, polished interspaces. Parapsidal lines with posterior one-third impressed. Mesopleuron with anterior impressed area polished, extremely shallowly reticulate, with sparse, simple hairs; posterior raised area reticulate anteriorly, impunctate, polished posteriorly. Propodeum coarsely, shallowly reticulate. Pterostigmal cell 0.38x length of marginal cell on costa. **Abdomen:** Plumose fringes dense only on second tergum apically. First tergum polished, finely punctate medially, moderately punctate laterally, apically 0.56x greatest width of second tergum. First sternum arcuate in cross section, anterior one-half with a mediolongitudinal carina not terminating anteriorly in a distinct tooth. Second tergum polished, finely, sparsely punctate with sparse, brachyplumose, recumbent hairs and long, simple, erect hairs; felt lines 0.4x length of tergum laterally. Second sternum moderately, shallowly, contiguously punctate with sparse, brachyplumose, recumbent hairs and long, simple, erect hairs; anteromedially tumid. **Genitalia:** Parameres arcuate dorsad, laterally straight, glabrous. Cuspis 0.4x free length of paramere, rodlike, with approximately 20 mesally-directed short hairs on mesal surface.

Female. Unknown.

Discussion. *Sphaeropthalma becki* most closely resembles *acontia* in external features, but the apical one-half of the mandibles is more tapered in the latter species. The very short marginal cell in *becki* facilitates distinction from *acontia*, which has the marginal cell approximately equal to the length of the stigma. Furthermore, the genitalia of the two species are very different. In *becki* the cuspis is rodlike and approximately four-tenths the free length of the parameres, but in *acontia* the cuspis scarcely exceeds the length of the penis valves. The holotype was selected for its large size, which best expresses the characteristics of the species. Size ranges from 3 to 7 mm, with the smaller specimens generally having both sculpture and abundance of plumose hairs reduced. In many of the smaller specimens, the frontal line is not visible.

Type data. Holotype ♂ (USNM): Hillside 0.85 mi NNW Mercury, Nye Co., Nevada, at light, W. E. Ferguson. Actual label data: Mercury, Nevada, N.T.S.; BYU-AEC Code MMT; VIII-23-64; ref. no. 1263. Six ♂ paratopotypes same data. Eleven paratopotypes same locality, at light; 1 ♂ VIII-3-64 (no. 1107); 2 ♂ VIII-10-64 (no. 1189); 4 ♂ VIII-20-64 (no. 1232); 4 ♂ VIII-21-64 (no. 1251). Twenty-three paratypes: **CALIFORNIA. Riverside Co.:** 6 mi S Palm Springs, 1 ♂ VI-20-64, at light (WEF). **San Bernardino Co.:** 12 mi N Earp, 2 ♂ V-5-53 (WEF). **NEVADA. Clark Co.:** 8.4 mi SE Indian Spring, 9 ♂ VIII-22-64, at light (WEF). **Nye Co.:** West side Frenchman Flat, 3 ♂ VIII-6-64, at light (no. 1117); 1 ♂ VII-13-61, can trap (no. 25); 2 ♂ VII-19-65, ultraviolet light (nos. 91 and 101); Cane Springs vicinity, 2 ♂ VIII-7-64, at light (no. 1134); Jackass Flats, 3 ♂ VIII-7-62, ultraviolet light (nos. 1086-1088); 5 ♂ VII-20-62,

ultraviolet light (nos. 1101-1105). Washoe Co.: 1 mi NW Nixon, 2 ♂ VII-8-61, at light (WEF).

Distribution. This small mutillid is reasonably common at least locally throughout the Sonoran Desert of California, the Mojave Desert, and at least the lower valleys of the western Great Basin Desert. Its abundance is not indicated by most collections because its small size makes it inconspicuous at light-traps, and a special effort must be made to catch individuals as they fly among the larger insects.

Sphaeropthalma (Micromutilla) brachyptera (Schuster)

Photopsis brachyptera Schuster, 1945. Pan-Pacific Entomol., 21:149.

Sphaeropthalma (Micromutilla) yavapai Schuster, 1958. Entomol. Amer., 37(n.s.):19. New synonymy.

Type data. *Photopsis brachyptera,* holotype ♂ Berkeley, California. *Sphaeropthalma yavapai,* holotype ♂ Kirkland, Peeples Valley, Yavapai Co., Arizona (data provided verbally by Schuster). Both specimens are the property of Cornell University, but were still in the Schuster collection in 1959. A paratype of *yavapai* is in the University of Minnesota collection. The unique type of *brachyptera* appears to be an intersex, because the reductions of wings, eyes, and ocelli are comparable reductions in maleness. Such an individual might result from either genetic, nutritional, or other environmental influences. I extracted the genitalia far enough to ascertain that they are identical to those of the normal *yavapai.* The small size of the *brachyptera* holotype (4.7 mm), as in small specimens of other species, also is the cause of reduced sculpture and pubescence. Consequently, this specimen should be compared with larger specimens in the 7-9 mm range as well as with a series in the intermediate range, so that the transition of character expressions can be observed.

Discussion. Thirty-one specimens of this widespread species were collected from the test site at incandescent and ultraviolet light-traps, but not in can pit-traps. Although *brachyptera* occurs in both the Great Basin and Mojave Desert portions of the test site, it was not collected with other species on the gently sloping floors of the valleys. All collections were made during August, which correlates with the time of intensive light-trap collecting rather than with the activity cycle of *brachyptera.* Collection data follow: 3 ♂ hillsides near Mercury (4000-4200 ft); 14 ♂ 0.9 mi W area 12 residences (5500 ft); 1 ♂ Rainier Mesa road (5800 ft); 10 ♂ 3 mi S area 12 residences (6200 ft). The vegetation at these localities included *Quercus gambelii* and *Pinus monophylla, Juniperus osteosperma* and *Coleogyne ramosissima,* nearly pure *C. ramosissima,* and "mixed vegetation," but not Larrea-Franseria, and other communities of the valley floors.

Specimens in my collection are from the area including the Coast Ranges of California, east to Mono Lake and the Nevada Test Site, south to the Rio Mayo of Sonora, Mexico, and eastward in Arizona to the Chiricahua Mountains. In specimens from the latter area the gaster, legs, antennae, and pterostigma are considerably darkened. This correlates with the integumental darkening of other species which occur in the same area (see discussion of *S. pallida*). Although *brachyptera* has not been collected from the valley floors at the test site, I have taken it in similar places where *Larrea divaricata* grows at Organ Pipe National Monument in Arizona, and 8 mi NE of Mesa, Arizona.

Sphaeropthalma (Micromutilla) difficilis (Baker), new combination

Photopsis difficilis Baker, 1905. Invert. Pacifica, 1:114-115.

Sphaeropthalma (Micromutilla) maricopella maricopella Schuster, 1958. Entomol. Amer., 37 (n.s.):17. New synonymy.

Sphaeropthalma (Micromutilla) maricopella purisimella Schuster, 1958. Entomol. Amer., 37 (n.s.):17. New synonymy.

Sphaeropthalma (Micromutilla) maricopella castanea Schuster, 1958. Entomol. Amer., 37 (n.s.):17. New synonymy.

Sphaeropthalma (Micromutilla) californiense californiense Schuster, 1958. Entomol. Amer. 37(n.s.):18. New synonymy.

Sphaeropthalma (Micromutilla) californiense fuscatella Schuster, 1958. Entomol. Amer., 37(n.s.):18. New synonymy.

Sphaeropthalma (Micromutilla) quijotoa quijotoa Schuster, 1958. Entomol. Amer., 37(n.s.):18. New synonymy.

Sphaeropthalma (Micromutilla) quijotoa parrasia Schuster, 1958. Entomol. Amer., 37(n.s.):18. New synonymy.

Type data. *Photopsis difficilis*, holotype ♂ Claremont, California (CU); *Sphaeropthalma maricopella maricopella*, holotype ♂ California (CU); paratypes 2 ♂ Hopkins Well, Riverside, California (CIS). *Sphaeropthalma californiense californiense*, holotype ♂ Mt. Diablo, Contra Costa Co., California (CAS); paratypes: ♂ Antioch, Contra Costa Co., California (WEF); ♂ Antelope Is., Davis Co., Utah (CIS). Although type localities were given in Schuster's key for each of the other new taxa (except *fuscatella*) listed above in synonymy, apparently type specimens are not available for study because they have not been designated for those names.

Discussion. Twenty-seven specimens were collected from Mercury, Frenchman and Yucca Flats, and Cane Springs at the test site, but not in the Pinyon-Juniper community on Rainier Mesa. This is a very widespread species which is represented in my collection by specimens from many localities in the Great Basin Desert and throughout the southwest, from coastal California and Mexico east to Las Cruces, New Mexico.

The taxonomic treatment of this species given by Schuster (1958) overlooked the valid name *difficilis*, and stressed differences without equal emphasis on similarities. Consequently, the small, geographically isolated samples which he studied appeared to him distinct enough to bear different names. The unifying characteristics of the many slight morphological and color variants are the convex clypeus, deeply excised mandibles, more or less petiolate condition of the first abdominal segment, and the form of the genitalia. The cuspis is more or less rodlike, slightly bulbous at the apex, and approximately two-thirds the length of the parameres. It bears numerous ventrally-directed long hairs on its entire ventral surface. In addition, the parameres at about mid-length bear at least a few, and usually many long hairs directed mesally and attached to the mesal surface.

I have studied the holotypes of *difficilis* and *californiense californiense*, and paratypes of *maricopella maricopella*. On the basis of a two-week visit with Schuster in 1959 and subsequent correspondence with him, I judge that type specimens have never been designated for the other names listed in synonymy above. Schuster's 1958 key, therefore, provides the only available descriptive information relating to these names. The range of eye sizes given by him clearly indicates that eye size differences form a continuum rather than distinctly different categories. He expressed the distance between the eye and the lateral ocellus as unity, and compared the longest dimension of the eye to that unit of length, with the following results.

Eye Size Range	Taxa
1.6 - 1.9	*californiense californiense* and *c. fuscatella*
2.1 - 2.2	*maricopella maricopella* and *m. castanea*
2.2 - 2.35	*quijotoa quijotoa*
2.5 - 2.6	*quijotoa parrasia*
2.6 - 2.8	*maricopella purisimella*

It is especially significant that the center of the range of eye size in "subspecies" of *maricopella* is not occupied by a subspecies of *maricopella*, but a different "species."

Sphaeropthalma (Micromutilla) macswaini, new species

Diagnosis. Male: Length 7.5 mm. Integument testaceous except head, antennae and legs slightly lighter. Mandible with posterior margin deeply excised, with subtending tooth large, protuberant, rounded (Fig. 6). Clypeal disc longitudinally concave, transversely straight, with margin truncate and carinate apically, and median base not protuberant or carinate. Mesosternum with one or two tiny denticulations on each side of mid-ventral line. Coxae and trochanters unarmed. Sternal felt lines approximately two-thirds length of those on second tergum. Pygidium polished, with extremely shallow micropunctures.

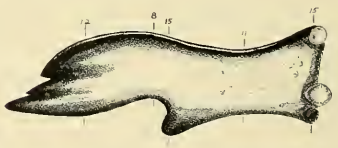

Fig. 6. Mandible of *Sphaeropthalma (Micromutilla) macswaini*. Numbers indicate transverse measurements.

Description. Head: Integument polished, with outline dorsad of eyes inflated dorsolaterally, not forming an arc of a circle in frontal view;

punctures fine (diameters 1-2 units), sparse. Measurements in micrometer units: eye 42, ocellocular distance 19, ocellar length 15. Interocellar area slightly darkened. Mandibles overlap dorsoventrally; distal one-half not twisted on its axis; carina of anterior margin well developed, complete, expanded anteriorly at bend; measurements given in Fig. 6. Apical mandibular teeth with 1° tooth basal width 0.6x and length 2x the 3° tooth; 2° tooth basal width 0.25x and length 1x the 3° tooth. Clypeal surface polished, glabrous, impunctate, apex not impressed below anterior margin of mandibles. **Thorax:** Pronotum dorsally and laterally coarsely, shallowly punctate except rugose on posterolateral margin. Mesonotum finely, shallowly punctate, the punctures approximately four diameters apart, with interspaces polished, glabrous. Parapsidal lines with posterior one-half impressed. Mesopleuron with anterior impressed area finely, shallowly, sparsely punctate, the punctures bearing long and short, brachyplumose hairs; posterior raised area reticulate. Propodeum coarsely reticulate. Pterostigmal cell testaceous, 1.2x length of marginal cell on costa. **Abdomen:** Plumose fringe moderately dense on apex of second tergum only. First tergum polished, minutely and sparsely punctate dorsally, finely punctate laterally, apically 0.52x greatest width of second tergum. First sternum arcuate in cross section, anterior one-half with a mediolongitudinal carina, not terminating in a tooth anteriorly. Second tergum polished, moderately punctate, the punctures one to two diameters apart except contiguous anterolaterally, with short, brachyplumose, recumbent hairs and long simple hairs; felt lines one-half length of tergum laterally. Second sternum moderately, closely punctate, with brachyplumose recumbent hairs and sparse, erect simple hairs, anteromedially tumid. **Genitalia:** Parameres arcuate dorsad and mesad. Cuspis length two-thirds free length of paramere, basally large, gradually tapered to a point apically, arcuate mesad, with mesal surface concave and bearing short, mesally directed hairs.

Female. Unknown.

Discussion. Although the mesosternum of *macswaini* bears tiny denticulations, it is not referable to either *Photomorphus* or *Odontophotopsis* on the basis of the peculiar genitalia. By ignoring the tiny denticulations, *macswaini* keys readily to *Micromutilla*, species group *hyalina*, in Schuster's 1958 key, but does not fit either alternative of couplet three because the petiole is not obviously petiolate, but it has a well-developed clypeus. Since the species of *Micromutilla* have more varied genitalia than *Photomorphus* and *Odontophotopsis*, *macswaini* seems to fit best into *Micromutilla*, at least until more of the undescribed species have been studied and described. Size ranges from about 4 to 9 mm. None of the specimens has well-developed abdominal plumose hairs, even on the second tergum. The cuspis length varies between two-thirds and three-fourths the free length of the paramere. The combination of the distinctive mandibles, with the broad tertiary tooth and the very prominent, rounded tooth on the posterior margin, plus the unusual genitalia, permit quick differentiation of *macswaini* from all of the other described nocturnal mutillids.

Type data. Holotype ♂ (USNM): 2.1 mi NE Mercury, Nye Co., Nevada; VIII-24-64; at light, W. E. Ferguson. Actual label data: Mercury, Nevada, N.T.S.; VIII-24-64; BYU-AEC Code 5CH(T); ref. no. 1277. Fifteen paratypes: **ARIZONA. Yuma Co.:** Dome, 1 ♂ VII-21-24 (CAS). **CALIFORNIA. Imperial Co.:** Kane Springs, 1 ♂ X-3-23 (CAS); 2 ♂ foot of mts. W Salton Sea beach, VII-23-52 (CAS). **Riverside Co.:** Magnesia Canyon, 1 ♂ VII-2-52, 4 ♂ VII-20-52 (UCD); Dead Indian Canyon, 3 ♂ VIII-6-65, at light (WEF); Palm Desert, 1 ♂ IV-11-50 (UI); Palm Springs, 1 ♂ V-29-39 (CAS). **San Bernardino Co.:** Cronise Valley, 1 ♂ IV-29-56 (CIS); 12 mi N Earp, 2 ♂ V-5-53 (WEF). **NEVADA. Nye Co.:** Mercury, code MMT, 1 ♂ VII-10-64, no. 1183, 1 ♂ VIII-21-64, at light, no. 1249.

Distribution. Although large collections of nocturnal Mutillidae have been made in the Great Basin Desert, *macswaini* has not been found there. Collection records cited above suggest that *macswaini* is a hot-desert species, and therefore might not occur outside of the Sonoran and Mojave Deserts. At the test site it occurs as high as 4200 ft.

Sphaeropthalma (Micromutilla) pallida (Blake)

Agama pallida Blake, 1871. Trans. Amer. Entomol. Soc., 3:263.

Sphaeropthalma (Micromutilla) arizonae Schuster, 1958. Entomol. Amer., 37(n.s.):16. New synonymy.

Type data. *Agama pallida*, holotype ♂ Texas (ANSP type 4552). *Sphaeropthalma ari-*

zonae, holotype ♂ Tucson, Arizona, June 5, 1935, Bryant (UM).

Discussion. Seven specimens were taken at the test site in August between approximately 4000 and 5500 ft. Although a large number of mutillids in the small end of the size range were obtained during the limited light collecting at the test site, this species apparently does not occur at lower elevations there, and is not very abundant.

The new synonymy cited above is based on examination of the type specimens and a series of specimens in the University of Minnesota collection. The genitalia of the holotypes are identical as described above in the discussion of *acontia*, but the differences described by Schuster (1958:16) in the key which validated the name *arizonae* simply are expressions of the range of variation that occurs in this species. The holotype *arizonae* is only 3.5 mm in length. With size reduction, sculpture is reduced, and the length of the first flagellar segment becomes slightly reduced in relation to the length of the second segment and pedicel. Coloration also is variable. In the lower elevations (below approximately 4000 ft) the body usually is uniformly testaceous with slightly lighter legs and antennae. However, there is a tendency toward darkening of the second abdominal segment, and this can be detected even at the lower elevations. At 5400 ft in the Chiricahua Mts. of Arizona, the head, thorax, and petiole are ferruginous and the gaster castaneous, but the legs are lighter than the thorax. At higher elevations (5900 ft in the Guadalupe Mts. of New Mexico), the legs and antennae are darkened also, and the humeral angles of the pronotum are darkened in some specimens. Farther east, in Nolan County on the Texas plains at 2000 ft, *pallida* has the coloration of test site specimens. Integumental darkening with increasing altitude, as described here, is not restricted to *pallida*, but is found in most other species which occupy a wide altitudinal belt. Extensive collections will be required to determine more completely the range of *pallida*.

Distribution. Mojave and Sonoran Deserts, east to Texas.

Sphaeropthalma (Micromutilla) parapenalis, new species

Diagnosis. **Male:** Length 9 mm. Integument entirely ferruginous. Mandibles without posterior margin excised, without a tooth on the posterior, basal margin, more or less parallel-sided from base to base of apical teeth. Clypeal disc longitudinally concave, transversely straight, with a pair of blunt, short teeth apically, basally produced into a prominent tubercle. Mesosternum moderately, shallowly punctate, without tubercles or processes. Coxae and trochanters unarmed. Sternal felt lines reduced to tufts approximately 0.2x the length of tergal felt lines. Pygidium polished, impunctate.

Description. Head: Integument with outline dorsad of eyes forming an arc of a circle in frontal view; punctures moderate, confluent. Measurements in micrometer units: eye length 42, ocellocular distance 22, ocellar length 16. Interocellar area not darkened. Mandibles overlap anteroposteriorly; posterior margin of apical one-half twisted ventrad, anterior margin bearing a distinct carina from base to tertiary apical tooth; measurements given in Fig. 7. Apical mandibular teeth with 1° tooth basal width 1x and length 3x the 3° tooth; 2° tooth basal width 0.75x and length 1.3x the 3° tooth. Clypeal surface polished, with sparse micropunctures bearing short or long hairs; apex not impressed below anterior margin of mandibles. Antenna with first flagellar segment 0.77x the length of second segment. Frontal line and preocellar pit absent. **Thorax:** Pronotum shallowly, coarsely, confluently punctate, except polished and shallowly rugose on posterolateral margin. Mesonotal punctures moderate, shallow, one half puncture width apart, with flat, polished interspaces. Parapsidal lines with posterior one-half impressed, Mesopleuron with anterior impressed area polished, with small, scattered punctures, and micropunctures bearing fine, simple hairs on the interspaces; posterior raised area reticulate, with narrow, polished interspaces anteriorly, impunctate, polished posteriorly, with fine, scattered punctures bearing short, simple hairs. Propodeum coarsely, deeply reticulate. Pterostigmal cell castaneous, 0.82x length of mar-

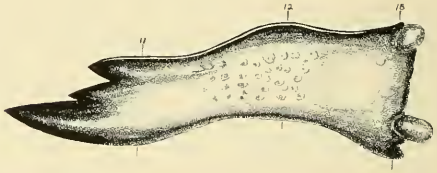

Fig. 7. Mandible of *Sphaeropthalma (Micromutilla) parapenalis* Ferguson. Numbers indicate transverse measurements.

ginal cell on costa. Wing distinctly infuscated apicad in a band posterior to stigma. **Abdomen:** Plumose fringes dense only on second tergum apically. First tergum moderately, confluently punctate throughout, apically 0.49x greatest width of second tergum, first sternum arcuate in cross section, anterior one-half without a mediolongitudinal carina and distinct basal tooth. Second tergum polished, finely, sparsely punctate, with sparse, short, recumbent, and long, erect simple hairs, except more coarsely and closely punctate anterolaterally; subapical margin finely, confluently punctate, with short, simple hairs; felt lines 0.64x length of tergum laterally. Second sternum moderately, shallowly, subconfluently punctate, with long, erect, simple hairs, slightly tumid anteromedially. **Genitalia:** Parameres arcuate dorsad, laterally straight, glabrous. Cuspis 0.38x free length of paramere, rodlike, with approximately 12 mesally-directed short hairs attached to the mesal surface.

Female. Unknown.

Discussion. In Schuster's paper (1958:14), this species was misidentified as *Sphaeropthalma (Micromutilla) juxta* (Blake) to which it keys. The name *juxta* appears again, on page 32 in Schuster's key to the species of the subgenus *Photopsis,* with which it should be associated. The name then should properly read *Sphaeropthalma (Photopsis) juxta* (new combination).

Sphaeropthalma parapenalis is distinct from all other North American nocturnal mutillids in having the parapenal lobes of the parameres impressed, concave, membranous dorsally, and not closely clasping the penis valves laterally. This species usually can be recognized readily without the use of the genital characters by means of the following combination of characters: mandibles with uninterrupted posterior marginal carina, wings with distinct infuscation extending from stigma to posterior margin and more or less distinctly to the apex of the wing. Furthermore, the pubescence of the last two segments of the abdomen is distinctly infuscated, whereas the remaining pubescence is hyaline, and the petiole is more coarsely sculptured than in most species. As is usual in the nocturnal Mutillidae, the smallest specimens have the infuscation and coarseness of sculpture considerably reduced. The distinctness of this species warrants placing it in a group by itself, as Schuster has done. However, since the name *juxta* belongs to another species in another subgenus, the group name *parapenalis* should now be used for the species *parapenalis.*

Type data. Holotype ♂ (CAS): Mt. Diablo, Contra Costa Co., California; VII-11-54; at light, W. E. Ferguson. Paratypes: **ARIZONA. Cochise Co.:** Chiricahua Mts., 1 ♂ VI-27-49 (OSU); Chiricahua Mts., Stewart For. Camp, Cave Creek Canyon, 3 ♂ IX-(13-14)-52 (CAS); Chiricahua Mts., S. W. Research Sta., 2 ♂ IX-1-58, 1 ♂ IX-6-58 (CIS); Chiricahua Mts., Pinery Cn., 1 ♂ VII-30-57 (UA); Chiricahua Mts., 5 mi W Portal, 1 ♂ VIII-5-58 (UCD); 1 ♂ IX-9-59, 1 ♂ VII-2-61, 1 ♂ VII-7-61 (WEF); 3 ♂ VIII-28-57 (UI); 1 ♂ VI-13-58 (WEF); Chiricahua Mts., 3.5 mi W Portal, 3 ♂ VIII-13-52 (CAS); Chiricahua Mts., 15 mi W Portal, 1 ♂ VIII-4-58 (UCD); Portal, 1 ♂ VI-4-59; 1 ♂ VI-23-59 (UCD); 9 mi W Portal, 3 ♂ VII-1-64 (WEF); Huachuca Mts., 1 ♂ VII-36 (CAS); Huachuca Mts., Carr Canyon, 1 ♂ VIII-29-52 (CAS); 8 mi N Bisbee, 1 ♂ VIII-11-52 (CAS); 9 mi S McNeal, 1 ♂ VIII-30-58 (CIS). **Coconino Co.:** Oak Creek Canyon, Midgley Bridge, 2 ♂ VIII-25-52 (CAS). **Graham Co.:** Graham Mts., Noon Creek, 3 ♂ VIII-8-55 (UA, WEF); Thatcher, 2 ♂ VI-18-51, 1 ♂ VI-20-50, 1 ♂ VI-24-50, 1 ♂ VI-26-51 (UCD). **Pima Co.:** Catalina Mts., mile 6, 2 ♂ VII-14-55 (WEF); Santa Catalina Mts., Mt. Lemmon Lodge, 2 ♂ VII-24-52 (UCD). **Santa Cruz Co.:** Santa Rita Mts., Madera Canyon, 1 ♂ VIII-15-40 (CAS); 1 ♂ VII-10-57 (UCD), 1 ♂ VII-14-59 (UA). **Yuma Co.:** San Luis, 1 ♂ VIII-11-40 (CAS). **CALIFORNIA. Alameda Co.:** Berkeley, 1 ♂ VII-14-31 (UCD). **Butte Co.:** Oroville, 1 ♂ VII-13-26 (CDA). **Calaveras Co.:** San Andreas, 1 ♂ VI-16-34 (CAS). **Colusa Co.:** Colusa, 1 ♂ VI-29-59, 1 ♂ VII-1-59, 1 ♂ VII-15-59 (UCD); College City, 1 ♂ VII-9-59 (UCD). **Contra Costa Co.:** 5 mi W Brentwood, 2 ♂ IX-5-58 (WEF); Danville, 1 ♂ VII-8-49, 2 ♂ XII-17-50, 1 ♂ VIII-27-50 (CAS); Martinez, 1 ♂ IV-8-11 (CAS); Mt. Diablo, 1 ♂ VI-11-60, 4 ♂ VII-11-54, 1 ♂ VII-11-56, 2 ♂ VII-19-61, 1 ♂ VII-29-56, 3 ♂ VIII-16-58, 1 ♂ IX-22-56, 4 ♂ IX-24-60, 1 ♂ IX-29-58 (WEF); Pleasant Hill, 1 ♂ VII-19-61, 1 ♂ VII-28-58, 1 ♂ VII-18-52 (WEF); Somersville, 2 ♂ VI-27-56 (WEF); Walnut Creek, 1 ♂ VIII-6-61 (WEF). **Fresno Co.:** Pine Flat Dam, 1 ♂ VIII-5-52 (WEF). **Kern Co.:** Woody, 3 ♂ VII-30-59 (UCD). **Kings Co.:** Lemoore 1 ♂ VIII-11-59 (LACM). **Lake Co.:** Lucerne, 1 ♂ VII-7-51 (CAS); Soda Bay, 3 ♂ VII-25-58, 1 ♂ VII-17-59 (UCD); Lower Lake, 1 ♂ VII-3-59 (UCD). **Los Angeles Co.:** Pasadena, 1 ♂ VIII-4-15 (UCR). **Mendocino Co.:** Ukiah, 1 ♂ XII-22-59 (CDA); Rancheria Creek at Yale Creek, 5 ♂ VII-25-54 (CAS). **Merced Co.:** Dos Palos, 1 ♂ VI-26-57 (WEF). **Mono Co.:** Cole-

ville, 1 ♂ VII-2-48, 1 ♂ VI-29-48, 1 ♂ VII-10-48, 1 ♂ VII-12-48, 2 ♂ VII-16-48, 2 ♂ VII-17-48, 1 ♂ VII-19-48, 1 ♂ VII-28-48, 1 ♂ VII-31-48 (WEF). **Monterey Co.:** Jamesburg, 1 ♂ VII-9-58 (UCD). **Napa Co.:** Mt. George, 1 ♂ no date (WEF). **Sacramento Co.:** Rio Linda, 4 ♂ VI-26-59, 1 ♂ VIII-23-57, 3 ♂ VII-15-55, 2 ♂ VIII-9-55, 4 ♂ VI-29-56, 1 ♂ VII-6-56, 1 ♂ IX-7-56, 2 ♂ VI-28-57, 1 ♂ VII-5-57, 7 ♂ VII-11-57, 8 ♂ VII-19-57, 1 ♂ VII-26-57, 2 ♂ VIII-7-57 (UCD); Carmichael, 1 ♂ VI-23-31, 1 ♂ VI-27-55, 1 ♂ VIII-1-55 (UCD); Fair Oaks, 1 ♂ VI-25-36 (UCD). **San Mateo Co.:** Menlo Park, 1 ♂ I-05 (CAS). **Santa Clara Co.:** San Antonio Val, 2 ♂ VIII-17-49, 1 ♂ VII-30-49 (CIS); New Almaden, 1 ♂ IX-10-64, 1 ♂ VIII-5-64 (WEF). **Shasta Co.:** Redding, 1 ♂ 1958 (UCD). **Solano Co.:** Vacaville, 1 ♂ VII-28-48, 1 ♂ VIII-30-49, 2 ♂ IX-19-52, 1 ♂ VIII-15-53, 1 ♂ VI-9-54, 1 ♂ VII-16-54, 1 ♂ VI-29-56 (UCD). **Sonoma Co.:** Preston, 2 ♂ VII-16-17 (CAS). **Tehema Co.:** Dairyville, 1 ♂ VII-9-56 (UCD); Red Bluff, 3 ♂ VII-9-56, 2 ♂ VII-20-56, 1 ♂ VIII-16-56, 2 ♂ IX-7-56, 1 ♂ IX-21-56 (UCD); Los Molinos, 2 ♂ VII-20-56, 1 ♂ VIII-23-56 (UCD). **Tulare Co.:** Pixley, 1 ♂ VIII-7-59 (LACM). **Yolo Co.:** Davis, 1 ♂ VI-17-59, 1 ♂ VI-22-59, 1 ♂ VII-8-59, 1 ♂ VIII-19-50, 1 ♂ VI-22-54, 1 ♂ VII-17-59, 2 ♂ VIII-4-55, 2 ♂ VIII-10-55, 1 ♂ VIII-5-58, 1 ♂ VIII-12-53, 1 ♂ IX-23-46 (UCD); 4 mi SW Dunnigan, 1 ♂ IV-25-59 (UCD); 4 mi SE Dunnigan, 2 ♂ VII-1-59, 1 ♂ VII-8-59, 2 ♂ VII-28-59 (UCD); 7 mi NW Dunnigan, 3 ♂ VII-1-59, 2 ♂ VII-6-59, 1 ♂ VII-14-59, 4 ♂ VII-12-59, 1 ♂ VII-16-59, 1 ♂ VII-21-59, 1 ♂ VII-28-59, 1 ♂ IX-2-59, 1 ♂ IX-10-59 (UCD); 2 mi SE Dunnigan, 1 ♂ VI-17-59 (UCD); 8 mi NW Winters, 4 ♂ VII-13-59, 1 ♂ VII-28-59, 1 ♂ VIII-5-59, 2 ♂ VIII-28-59, 1 ♂ IX-2-59 (UCD); 9 mi W Zamora, 1 ♂ VII-16-59, 1 ♂ VIII-28-59, 1 ♂ VII-1-59 (UCD); Rumsey, 3 ♂ VII-23-55, 1 ♂ VIII-5-55, 1 ♂ VIII-11-55 (UCD); Esparto, 1 ♂ VII-3-56, 1 ♂ VIII-13-59 (UCD). **IDAHO. Ada Co.:** Boise, 2 ♂ VII-26-53 (CAS). **Cassia Co.:** 5 mi NE Malta, 2 ♂ VII-16- 52 (UI). **OREGON. Umatilla Co.:** Umatilla, 6 ♂ VII-10-58 (WEF); Cold Springs Junction, 4 ♂ VIII-9-60 (WEF). **NEVADA. Eureka Co.:** 27.5 mi W Carlin, 1 ♂ VII-10-59 (CAS); **Nye Co.:** 35 mi NNW Mercury, Nevada Test Site, 1 ♂ VIII-11-64 BYU-AEC code 12M(T), no. 1201; 1 ♂ VIII-11-64 BYU-AEC code 12CC(T), no. 1206; 1 ♂ VIII-5-65 BYU-AEC code ECH(TB), no 1085. **TEXAS. Nolan Co.:** Sweetwater, Texas Exp. Sta., 1 ♂ VIII-3-37 (TAM); 1 ♂ VII-28-37 (WEF). **UTAH. Juab Co.:** Ibapah, Callao Pass, 1 ♂ VIII-3-53 (UU). **Millard Co.:** Delta, 1 ♂ VIII-3-49 (USU). **Weber Co.:** Ogden, 1 ♂ VII-8-59 (CIS). **WASHINGTON. Asotin Co.:** 2 mi S Asotin on river bank, 2 ♂ VII-23-63 (DAG); 1 ♂ VII-23-63 (WEF); 1 ♂ VII-23-62 (JZW). **MEXICO. Chihuahua:** Catarinas, 1 ♂ VII-25-47 (AMNH). **Coahuila:** Cabos, 1 ♂ VIII-21-47 (AMNH). **Durango:** Nombre de Dios, 1 ♂ VIII-6-51 (CIS). **Zacatecas:** 15 km E Sombrerete, 1 ♂ VIII-28-51 (CIS).

Distribution. This is one of the most distinct nocturnal mutillids of North America, morphologically as well as distributionally. In California it occurs through the coastal valleys, the Central Valley, and the coastal as well as Sierran foothills. Farther inland it is found throughout the Great Basin Desert, but apparently only characteristically on the slopes of the ranges rather than in the basins. At the test site this is illustrated by only three specimens captured at three places along the base of Rainier Mesa, 35 miles NNW of Mercury. The dominant vegetation there is *Coleogyne ramosissima*, with sparse *Juniperus osteosperma*. Even large collections at altitudes from 3800 to 4200 ft at the test site did not contain *parapenalis*. In Arizona, *parapenalis* has been found only within the lower edge of the tree belt which usually is associated with the mountains that rise rather abruptly from the desert. Its distribution extends farther east onto the Texas plains at altitudes of at least 2000 ft, and south into Mexico at altitudes up to at least 7500 ft. I have not seen any specimens from the Mojave or Sonoran Deserts.

Sphaeropthalma (Micromutilla) sonora Schuster

Sphaeropthalma (Micromutilla) sonora Schuster, 1958. Entomol. Amer., 37(n.s.):16.

Type data. Holotype ♂ Tucson, Arizona (UM). Paratypes: 2 ♂ Palm Springs, Riverside Co., California (LACM); 1 ♂ Borego, San Diego Co., California (CIS); 2 ♂ Hopkins Well, Riverside Co., California; 1 ♂ Coalinga, Fresno Co., California (CIS); 1 ♂ locality unknown to me (UM).

Discussion. Ninety specimens were collected at the test site from ten different localities of the desert slopes and valleys below the lower limit of the Coleogyne and the Pinyon-Juniper communities, or approximately 4500 ft.

Although *sonora* is locally abundant in the Sonoran and Mojave Deserts, it occurs at least as far north as Fort Churchill and Pyramid

Lake, Nevada, where I have collected it commonly at light. The existence of *sonora* at Yucca Flat thus fits this more extensive, though very imperfectly known, distribution pattern.

Sphaeropthalma (Micromutilla) yumaella Schuster

Sphaeropthalma (Micromutilla) yumaella Schuster, 1958. Entomol. Amer., 37(n.s.):19.

Type data. Holotype ♂ Wellton, Yuma Co., Arizona. The specimen is the property of Cornell University, although it probably still is located in the Schuster collection.

Discussion. Six of ten specimens were collected at incandescent light at Mercury. The other four were taken at incandescent and ultraviolet lights, and from a can pit-trap in study area 5A on the west side of Frenchman Flat in July and August. This species should be present in the Great Basin portion of the test site, since specimens in my collection indicate that the distribution includes the area from Pyramid Lake, Nevada, south into Baja California, Mexico, and east to Portal, Arizona. Representatives of *yumaella* usually are among the smallest nocturnal mutillids, and hence probably were not captured in numbers proportionate to their actual abundance at the test site.

Sphaeropthalma (Photopsis) angulifera Schuster

Sphaeropthalma (Photopsis) angulifera Schuster, 1958. Entomol. Amer., 37(n.s.):32.

Type data. Holotype ♂ Bakersfield, California (CAS). Paratype ♂ Aberdeen, Owen's Valley, Inyo Co., California (ANSP).

Discussion. Seven specimens were collected at the test site from late June to early September within the altitudinal range of 3900 ft near Cane Springs, to 5400 ft at the base of Rainier Mesa. It is surprising that *angulifera* males have not been collected at lower elevations at the test site, because I have taken them at lights in the Mojave Desert near Lancaster and Ivanpah, but never in large numbers.

Sphaeropthalma (Photopsis) blakeii (Fox)

Photopsis Blakeii Fox, 1893. Proc. California Acad. Sci., (Ser. 2), 4:6.

Mutilla ceyx Fox, 1899. Trans Amer. Entomol. Soc., 25:262.

Type data. *Photopsis Blakeii*, lectotype ♂ San Jose del Cabo, Lower California, Mexico (CAS type no. 292). *Mutilla ceyx*, lectotype ♂ Calmali Mines, Lower California, Mexico (ANSP type no. 4653). Syntype ♂ El Paraiso, Lower California, Mexico (ANSP type no. 5054).

Discussion. Only three specimens were taken at light from Mercury, and from locality 5A on the west side of Frenchman Flat. *Sphaeropthalma blakeii* occurs rather commonly in the lower altitude deserts south into Mexico, but I have not collected individuals of this species farther north in the Great Basin Desert. This suggests that *blakeii* is at the limit of its distribution in the Mojave Desert portion of the test site.

The synonymy listed above was based on examination of all three of the cited type specimens, and comparisons of these with a long series of specimens from other localities (Ferguson, 1962:10).

Sphaeropthalma (Photopsis) ferruginea (Blake)

Agama ferruginea Blake, 1879. Trans. Amer. Entomol. Soc., 7:254.

Type data. Holotype ♂ Nevada (ANSP type no. 5615).

Discussion. Four of six specimens were taken at light in August between 5400 and 6100 ft from two localities at the foot of Rainier Mesa on the test site in typical Great Basin Desert vegetation. At the lower site, *Coleogyne ramosissima* was predominant with scattered *Juniperus osteosperma*. A fifth specimen was taken at light in August, approximately 2.3 mi NE of Mercury and 0.2 mi E of Mercury Highway, at 4200 ft. The sixth specimen was taken at light in July from locality 18M.

Specimens in my collection indicate that this species is characteristic of the Great Basin Desert. It also occurs westward to the Coast Ranges, and southward into the mountains of southern California where it occurs in the Pinyon-Juniper and the Oak-Grassland communities.

Sphaeropthalma (Photopsis) helicaon (Fox)

Mutilla helicaon Fox, 1899. Trans. Amer. Entomol. Soc., 25:254.

Photopsis lingulatus Viereck, 1903. Proc. Acad. Nat. Sci. Phila., 54:737. New synonymy.

Sphaeropthalma (Photopsis) carinata Schuster, 1958. Entomol. Amer., 37(n.s.):34. New synonymy.

Sphaeropthalma (Photopsis) helicaon coahuilae Schuster, 1958. Entomol. Amer., 37(n.s.):34. New synonymy.

Sphaeropthalma (Photopsis) helicaon diegueno Schuster, 1958. Entomol. Amer., 37(n.s.):35. New synonymy.

Type data. *Mutilla helicaon*, holotype ♂ Nevada (ANSP type no. 4642). *Photopsis lingulatus*, holotype ♂ La Jolla, San Diego Co., California (ANSP, type not numbered). *Sphaeropthalma carinata*, holotype ♂ Purissima, Baja California, Mexico (property of USNM, unique type not yet deposited by Schuster). *Sphaeropthalma coahuilae*, type material not designated, but presumably from the state of Coahuila, Mexico. *Sphaeropthalma helicaon diegueno*, until June 28, 1959, was represented by a male specimen on loan to Schuster from Cornell University and bearing the following label data: Porter 20; Cornell U., Lot 709, Sub.; Arizona; Specimen B 12 F; Holotype, *Sphaeropthalma helicaon* ssp. *diegueno* Schu. At that time Schuster discovered that this specimen had deeply excised mandibles with a large basal tooth, and therefore did not represent a variation of *helicaon*, nor could it be keyed to *helicaon diegueno* in his key which validated the latter name. Schuster then selected a new holotype male which bears the following label data: S. Carlos, Ariz., 12, 13 May '18, J. Ch. Bradley; Holotype, *Sphaeropthalma helicaon* ssp. *diegueno* Schu. This specimen also belongs to the Cornell University collection, but has not yet been deposited there by Schuster.

Discussion. One specimen was taken at light in June at Mercury. Label data from other specimens in my collection suggest that this species is characteristic of the Mojave and Sonoran Deserts, but not the Great Basin Desert. The rarity of *helicaon* at the test site apparently is indicative of the marginal nature of the environment there for this species.

The new synonymy listed above is based on a preliminary study of this species as a part of a revision of the subgenus *Photopsis*. I have examined all holotype specimens except that of *coahuilae*, which Schuster could not find as of July, 1959. However, specimens from Saltillo, Coahuila, Mexico, are on loan to me from the American Museum of Natural History, and appear to be this dark-headed form. *Sphaeropthalma carinata* is simply an individual which has a scutellar carina formed from the united margins of the punctures on each side of the midline. The expression of punctures and their separating ridges is so variable in a series of a dozen specimens from any given locality, that the variation in the species must exceed even that found in *carinata*. The genitalia probably contain the best taxonomic characters that indicate the unity of this species, and clearly distinguish it from all other known species of nocturnal North American Mutillidae. The parameres are arcuate dorsad, not arcuate mesad, acuminate, glabrous on apical one-half, basal one-half of mesal surface with dense, mesally-directed hairs; cuspis one-half the length of the parameres, rodlike, slightly arcuate, with sparse, long hairs attached to the ventral surface and directed ventromesad. When the genitalia have been extruded from the body, the dense, basal hairs of the parameres, described above, provide instant recognition of the species.

In discussing Schuster's subspecies concepts with him in 1959, he indicated that he studied only one or two specimens which represented each of the names that he used for the taxa listed in synonymy above. Certainly this is not an adequate basis for recognition of subspecies and closely related species in the nocturnal sphaeropthalmine Mutillidae. Schuster (1958: 43) stated of the group *albicincta*, in which he placed *helicaon*, "This is one of the very difficult and polymorphic complexes; the following key is frankly tentative." I consider this to be a good indication that the characters of coloration, eye and ocellar size, puncturation, clypeal convexity, and petiole proportions are so variable and difficult to describe precisely that identification according to Schuster's key is very difficult. Considerable variation is to be expected in a widespread species, but Schuster did not present distributional evidence in support of his taxonomic concepts. I believe it is better to consider that all of the above names are synonymous until enough specimens and distributional data have been massed to make intelligent decisions about possible resurrection of names.

Sphaeropthalma (Photopsis) unicolor (Cresson)

Mutilla unicolor Cresson, 1865. Proc. Entomol. Soc. Phila., 4:389.

Agama mendica Blake, 1871. Trans. Amer. Entomol. Soc., 3:259. New synonymy.

Mutilla auraria Blake, 1879. Trans. Amer. Entomol. Soc., 7:248. New synonymy.

Mutilla Aspasia Blake [not *Sphaerophthalma* (sic) *aspasia* Cameron 1895, Biol. Centrali-Amer., Insecta, Hymenoptera, 2:370.], 1879. Trans. Amer. Entomol. Soc., 7:250. New synonymy.

Mutilla Phaedra Blake, 1879. Trans. Amer. Entomol. Soc., 7:251. New synonymy.

Agama rustica Blake [not *Sphaerophthalma* (sic) *rustica* Cameron, 1895, Biol. Centrali-Amer., Insecta, Hymenoptera, 2:342.], 1879. Trans. Amer. Entomol. Soc., 7:252. Schuster, 1958, Entomol. Amer., 37(n.s.):32. New synonymy.

Photopsis nebulosus Blake, 1886. Trans. Amer. Entomol. Soc., 13:275. New synonymy.

Sphaerophthalma anthophora (sic) Ashmead, 1897. Proc. Southern California Acad. Sci., 1(3):5. New synonymy.

Mutilla monochroa Dalla Torre, 1897. Catalogus Hymenopterorum, 8:63. New name for *Mutilla unicolor* Cresson 1865, not *Myrmosa unicolor* Say, 1824, *in* Keating, Narr. Long's Second Expedition, 2:331.

Dasymutilla sumneriella Cockerell, 1915. Entomol., 48:249. New synonymy.

Sphaeropthalma (Photopsis) rustica ocellaria Schuster, 1958. Entomol. Amer., 37(n.s.):32. New synonymy.

Type data. *Mutilla unicolor*, lectotype ♂ California (ANSP type no. 1887). *Agama mendica*, holotype (?) ♂ Nevada (ANSP type no. 4551). *Mutilla auraria*, holotype (?) ♀ Nevada (ANSP type no. 4573). *Mutilla Aspasia* holotype (?) ♀ Nevada (ANSP type no, 4574). *Mutilla Phaedra*, holotype (?) ♀ Nevada (ANSP type no. 4575). *Agama rustica*, holotype (?) ♂ California (ANSP type no. 4550). *Photopsis nebulosus*, holotype (?) ♂ Nevada (ANSP type no. 4549). *Sphaerophthalma anthophora*, holotype ♂, allotype ♀ Los Angeles, California (USNM types no. 6113). *Dasymutilla sumneriella*, holotype ♀ La Jolla, California (USNM type no. 20409). *Sphaeropthalma rustica ocellaria*, holotype ♂ Berkeley, California (UM).

Characteristics of the named forms. Mutilla *unicolor* is typical of males with the integument entirely light ferruginous; pubescence aureous dorsally and ventrally on the abdomen; plumose fringes prominent only on segment two; eyes, ocelli, and wings normal. Females of this form have been identified as *aspasia* or *phaedra*.

Photopsis nebulosus is the form with the integument light ferruginous, except the femora slightly infuscated; pubescence hyaline except slightly aureous dorsally; eyes and ocelli normal. This was synonymized with *auraria* females on the basis of rearing the two sexes from cells of *Diadasia* (Linsley and MacSwain, 1952; Ferguson, 1962).

Agama rustica represents males with the integument ferruginous, except the thorax laterally; antennae, legs, and petiole castaneous to black; pubescence aureous; eyes, ocelli, and wings normal. Females usually were identified as *auraria*. Schuster (1958) used the name incorrectly for males with the coloration of *rustica*, but which have the abnormal condition of brachyptery and small eyes and ocelli. The type specimen is normal in these respects.

Sphaeropthalma rustica ocellaria (Schuster, 1958:32) is the name proposed in error for normal specimens like the type of *rustica*.

Agama mendica has the integument entirely castaneous to black, and pubescence entirely hyaline.

Sphaerophthalma anthophora males have the integument ferruginous, except the flagellum, legs, and thorax laterally black, with pubescence reddish aureous. Females have the integument translucent ferruginous, except the thorax laterally and the legs black. Pubescence is reddish.

Dasymutilla sumneriella is the same as *anthophora* females, and was synonymized by Krombein (1951).

Discussion. The long synonymy above is the result of study of well over one thousand specimens of this species, including all of the type specimens. *Sphaeropthalma unicolor* occurs from sea level on the Pacific Coast, eastward into the Mojave and Great Basin Deserts to Utah and New Mexico. In the north-south direction, it extends from Washington and Idaho into the coastal areas and middle altitudes of the northern mountains of Baja California. I have not seen specimens from the Sonoran Desert. The synonymy well represents the variability in this widespread species which occupies so many ecologically different yet intergrading environments.

At the test site, *unicolor* apparently is one of the most abundant nocturnal Mutillidae, ranking equally with *Odontophotopsis microdonta* Ferguson. It occurs from the valley floors to the Pinyon-Juniper and Artemisia communities at well over 7000 ft. At approximately the lower

limit of the junipers the ferruginous-colored valley form is replaced by the melanistic one, which is found only at the higher altitudes, above 5500 ft. Since the two forms apparently are not sympatric any place within their distribution, yet appear to have continuous distributions, it appears to me that one form may be gradually replacing the other. The more favorable conditions of the desert valleys and the Central Valley of California, as well as the Columbia and Snake River Valleys, certainly must permit more generations per year. Hence, if the ancestral form of *unicolor* were melanistic like the Great Basin form, and mutations for lighter coloration occurred in the lower altitude populations, the more rapid genetic turn-over there would have permitted rapid spread of lighter coloration in the areas of favorable climate. I have traced the limits of the two major color forms from southern Idaho, along the east flank of the Sierra Nevada, and along the basins and ranges where the Mojave and Great Basin Deserts interdigitate. These records show the same altitudinal relationship of the two male color forms, without the distributional overlaps which are characteristic of different species.

Collections at the test site include 76 females which were found in can pit-traps, while only four males were found in the same traps. During a brief period of intensive light-trapping in August, 1964, 36 of the lighter-colored males and 13 of the melanistic males were collected.

Sphaeropthalma (Photopsioides) amphion
(Fox)

Mutilla amphion Fox, 1899. Trans. Entomol. Soc. Amer., 25:263.

Photopsis abstrusa Baker, 1905. Invert. Pacifica, 1:113. New synonymy.

Photopsis nudatus Baker, 1905. Invert. Pacifica, 1:114.

Type data. *Mutilla amphion*, holotype (?) ♂ Nevada (ANSP type no. 4654). *Photopsis abstrusa*, holotype (?) ♂ Claremont, California (CU). *Photopsis nudatus*, holotype (?) ♂ Claremont, California (CU).

Discussion. Ten males of *amphion* were collected at the test site. In all of the collections made from autumn, 1959, to August 1, 1964, only one specimen was taken. This was found on the ridge which separates Frenchman and Yucca Flats, within a box-type live-catch trap used for mammals. Through intensive light-trapping in August, 1964, eight additional specimens were collected from the hillsides around Mercury, study area 5A on the west side of Frenchman Flat, and the area of *Quercus gambelii* and *Pinus monophylla* at the base of Rainier Mesa. One additional specimen was taken at ultraviolet light in the same general area on August 5, 1965.

The new synonymy listed above is based upon study of all of the type specimens and a series of more than sixty others. Schuster (1958: 38) synonymized *nudatus* with *amphion,* but considered *abstrusa* as a subspecies of *amphion.* This is absurd because the type specimens of *nudatus* and *abstrusa* were collected at the same locality. Schuster separated the two subspecies on the basis of proportions of marginal cell length and stigma length, depression of the clypeus, and body size. These factors are variable even within given localities, and size is independent of the other two variables. Figure 8 shows the variability in the proportions of stigma length compared with marginal cell length on

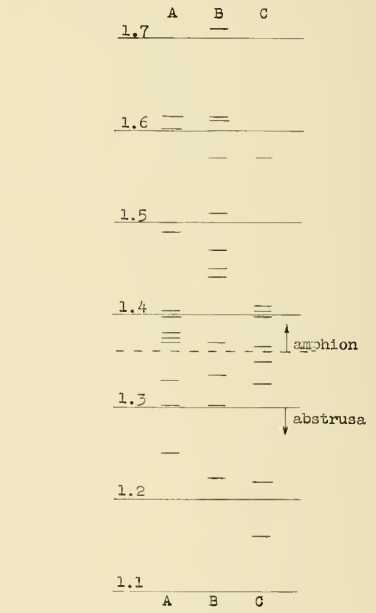

Fig. 8. *Sphaeropthalma (Photopsioides) amphion* (Fox) stigma length compared with marginal cell length (unity). Columns represent measurements of all individuals in population samples from: A, Nevada Test Site; B, New Almaden, Santa Clara Co., Calif.; C, Coleville, Mono Co., Calif. Arrows indicate limits of subspecies proposed by Schuster (1958).

the costa (expressed as unity) in a series of eight, ten, and twelve specimens, the total numbers taken from three widely separated localities. I believe that this graphic evidence establishes the former arbitrary and invalid division of this species into two subspecies.

Odontophotopsis (Odontophotopsis) armata Schuster

Odontophotopsis (Odontophotopsis) armata Schuster, 1958. Entomol. Amer., 37(n.s.):60.

Discussion. Fifty-two specimens were collected at incandescent light on the hillsides near Mercury and at Cane Springs. Apparently this is a Mojave Desert species and occurs on the valley slopes, but not in the bottoms of the valleys or as high as the Pinyon-Juniper community. This is the first locality recorded for this species since Schuster validated the name in a key, without designating a type specimen or type locality. The identification of this species, therefore, is based entirely upon Schuster's key.

Odontophotopsis (Odontophotopsis) clypeata Schuster

Odontophotopsis (Odontophotopsis) clypeatus Schuster, 1958. Entomol. Amer., 37(n.s.):59.

Type data. Holotype ♂ Tucson, Arizona (UM). Paratype ♂ Arizona (UM).

Discussion. Of fourteen specimens captured at the test site, seven were found in can pit-traps in study areas 5A and 5E on the west side of Frenchman Flat in July, August, and September, 1961. In the same general area, three specimens were collected at ultraviolet light and two at a gasoline lantern during August, 1964. Although much light-trapping was done at Mercury and the nearby hillside, only one specimen was taken there. Only one specimen (ref. no. 73) is from Yucca Flat, where it came to light. Specimens from can pit-traps were preserved in alcohol before being pinned; therefore, the lighter parts of the integument are darkened more than in specimens which were pinned while fresh and allowed to dry.

Little can be said about the distribution of *clypeata* at the test site except that it occupies the Mojave Desert portion, although one specimen was taken in Yucca Flat. It seems to be much less abundant than *O. microdonta* Ferguson, which is its closest relative (see discussion of *microdonta*). Additional material was examined from the following localities: St. George, Washington Co., Utah; 8 mi NE Mesa, Maricopa Co., Arizona; Organ Pipe National Monument, Pima Co., Arizona; and 6 mi S Palm Springs, Riverside Co., California.

Odontophotopsis (Odontophotopsis) cookii Baker

Odontophotopsis cookii Baker, 1905. Invert. Pacifica, 1:93.

Type data. Holotype ♂ Claremont, California (CU).

Discussion. Twelve specimens were collected from the test site. One of these came to light near Cane Springs (4000 ft), but all others were collected at incandescent or ultraviolet light along the base of Rainier Mesa. Those three areas contained *Coleogyne ramosissima; Juniperus osteosperma* and *Coleogyne ramosissima;* and *Quercus gambelii* and *Pinus monophylla.* Identification of this species was based on examination of the type specimen and comparison of the test site specimens with a large series from California. The test site specimens are different from all others in having the mesosternal tubercles reduced considerably, so that in some specimens they are inconspicuous. Otherwise, the key characteristics, form of the mandibles, genitalia, and sculpture appear to be identical in specimens from the test site and from California. When collections in intermediate localities can be made, it should be possible to determine whether or not the test site specimens should be given a different name.

Odontophotopsis (Odontophotopsis) inconspicua inconspicua (Blake)

Photopsis inconspicuus Blake, 1886. Trans. Amer. Entomol. Soc., 13:272.

Type data. Holotype (?) ♂ California (ANSP type no. 4610).

Discussion. Twenty-seven specimens were collected from the hills surrounding Mercury, the *Atriplex* area near the southwest edge of the playa in Frenchman Flat, Cane Springs, and in the lowest edge of the juniper belt at the base of Rainier Mesa. Although *O. inconspicua inconspicua* occurs in both the Mojave and Great Basin Desert portions of the test site, it apparently does not occur as high as the *Artemisia tridentata* association on the top of Rainier Mesa. This species occurs commonly in the Central Valley of California, and south into the Colorado

Desert of California, at least as far as Indio in Riverside County.

Odontophotopsis (Odontophotopsis) microdonta, new species

Diagnosis. Male: Length 9 mm. Integument of head, thorax, and petiole ferruginous; gaster castaneous; legs and antennae testaceous. Mandibles with posterior margin deeply excised, with subtending tooth large, protuberant, rounded. Clypeal disc longitudinally concave, transversely straight, with a pair of blunt, apical teeth, basally not protuberant or carinate. Mesosternal tubercles scarcely differentiated from puncture margins. Coxae and trochanters unarmed. Sternal felt lines approximately one-third length of those on second tergum. Pygidium polished, impunctate, apical fringe absent.

Description. Head: Integument polished, with outline dorsad of eyes forming an arc of a circle in frontal view; punctures fine (diameter 2 units), sparse. Measurements: eye length 47 units, ocellocular distance 16 units, ocellar length 16 units. Interocellar area darkened. Mandibles overlap dorsoventrally; anterior margin of distal one-half slightly twisted dorsad, and bearing a distinct carina from base to tertiary apical tooth. Apical mandibular teeth with 1° tooth basal width 1x and length 2x the 3° tooth; 2° tooth basal width 1x and length 1x the 3° tooth. Clypeal surface polished, with sparse micropunctures bearing long or short, simple hairs; apex not impressed below anterior margin of mandibles. Antenna with first flagellar segment 0.77x the length of second segment. Frontal line and preocellar pit distinct. **Thorax:** Pronotum dorsally and laterally coarsely, shallowly punctate except rugose on posterolateral margin. Mesonotum moderately, shallowly punctate (puncture widths 4 units) with flattened, narrow interspaces polished. Parapsidal lines entirely impressed. Mesopleuron with anterior impressed area moderately to finely punctate, sparsely plumose-hairy; posterior raised area moderately punctate to reticulate. Propodeum coarsely reticulate. Pterostigmal cell testaceous, 1.05x length of marginal cell on costa. **Abdomen:** Plumose fringes dense on segments two and three apically. First tergum moderately, closely punctate, apically 0.5x greatest width of second tergum. First sternum arcuate in cross section, with a mediolongitudinal carina on the anterior two-thirds, terminating anteriorly in a prominent blunt tooth. Second tergum polished, finely, sparsely punctate, the punctures two to three diameters apart, except anterolaterally more closely, coarsely punctate, with brachyplumose, recumbent hairs and erect simple hairs; felt lines one-half length of tergum laterally. Second sternum moderately, shallowly, contiguously punctate, with brachyplumose, recumbent hairs and erect simple hairs; anteromedially tumid. **Genitalia:** Parameres arcuate dorsad, laterally straight, glabrous. Cuspis length one-half free length of paramere, rodlike, flattened, with approximately twenty mesally-directed short hairs on mesal surface.

Female. Unknown. In spite of can pit-trap and light-trap records, it has not been possible to correlate the sexes of this species.

Discussion. *Odontophotopsis microdonta* is most closely related to *O. clypeata* Schuster except for the reduction of the mesosternal tubercles, but should key out to the latter species. The holotype was selected because its tubercles are well developed for this species. Even when the tubercles are absent, *microdonta* can be recognized as belonging to *Odontophotopsis* because of the typical genitalia (described above), with the cuspis about one-half the free length of the parameres, and the abundance of brachyplumose body hairs. The mesosternal tubercles, which are key generic characteristics, normally are so small that they can be easily overlooked. Hence, with the normal condition minimal, slight variation results in absence or in a relative prominence of the tubercles. Since this species very closely resembles *clypeata*, specimens with relatively distinct mesosternal tubercles may be mistaken for that species. However, the tubercles of *clypeata* are larger and are in a different place. In *microdonta* the tubercles are approximately two puncture widths anterior to the mesocoxae, but in *clypeata* they are approximately two puncture widths farther anterior. Punctures used as the basis for measurement lie lateral to the tubercles. An additional complication in identification involves variation in pigmentation of the gaster. Dark specimens are not a problem, but some specimens have the dark integumental pigment reduced to the vicinity of the felt lines, and occasionally specimens lack dark pigment entirely. In this case identification may be difficult, depending on the prominence of the mesosternal tubercles. Only a few specimens of *microdonta* have been observed with some pygidial fringe hairs, whereas specimens of *clypeata* characteristically have the fringe well-developed. In *clypeata* this character is variable, probably owing to abrasion and heredity, but

there is nearly always evidence of at least a few fringe hairs. *Odontophotopsis microdonta* differs further from *clypeata* by the slightly twisted mandibles mentioned in the description. The difference between twisted and untwisted is very subtle in this case, and difficult to describe and ascertain in individuals. However, in series of the two species separated on the basis of other characteristics, the distinction is more apparent. Furthermore, *clypeata* tends to have the medial base of the clypeus slightly more produced at its juncture with the frons than in *microdonta*.

Type data. Holotype ♂ (USNM): 5 mi NNW Mercury, Nye Co., Nevada (USGS Specter Range Quadrangle, 1 mi from Mercury Highway, at 3400 ft), ultraviolet light, W. E. Ferguson. Actual label data: Mercury, Nevada, N. T.S.; BYU-AEC Code 5M(TB); VIII-25-64; ref. no. 1298. Seven male paratopotypes same data. Seventy-eight paratypes: west side Frenchman Flat, 9 ♂ VIII-6-64, at light (code 5MT, no. 1115); 8 ♂ VIII-29-64, ultraviolet light (code 5AT, no. 1316); Cane Springs vicinity, 16 ♂ VIII-7-64 (codes CBT, CMT, nos. 1119, 1133); Mercury, CETO Bldg., 26 ♂ VIII-(10, 20, 21, 23)-64, at light (code MMT, nos. 1186, 1237, 1244, 1267); 2.2 mi NNE Mercury, 3 ♂ VIII-24-64, at light (code 5 CHT, no. 1279); west side Yucca Flat, 2 ♂ VIII-14-64, at light (code 1BB25T).

Additional material. The following specimens from the test site are not included in the type series because they have the normally light portions of the integument darkened, and the pubescence is matted owing to long preservation in alcohol before being pinned. Twenty-six males from can pit-traps: west side Frenchman Flat, 16 ♂ VII-11 to IX-19-61 (codes 5A and 5E); Study site CP, 5 ♂ VIII-28-59; Cane Springs, 2 ♂ IX-2-59; 1 ♂ VII-4-61. West side Yucca Flat, 1 ♂ VI-22-60 (code 1BF25C, no. 608). The following material in my collection from outside the test site was examined for comparison. **CALIFORNIA. Riverside Co.:** 25 mi S Ivanpah, 2 ♂ X-13-58, at light. **NEVADA. Lyon Co.:** Fort Churchill, 1 ♂ VII-9-61, at light.

Distribution. On the test site, as elsewhere, this species appears to be common in parts of the Mojave and Great Basin Deserts. The only known distribution is reported above.

Odontophotopsis (Odontophotopsis) obliqua Viereck

Odontophotopsis obliquus Viereck, 1925. Canadian Entomol. 56:112.

Odontophotopsis (Odontophotopsis) mellicausa [sic] *obliquus* Schuster, 1958. Entomol. Amer., 37(n.s.):59.

Type data. Holotype ♂ Vernon, British Columbia, Canada (CNC type no. 753).

Discussion. Thirty-two specimens were collected in the hills surrounding Mercury, at several sites in Frenchman Flat, at Cane Springs, several places in Yucca Flat, and on the higher alluvial slopes at the base of Rainier Mesa. This is essentially the same distribution at the test site as for *O. inconspicua inconspicua*. However, eleven *obliqua* were taken from can pit-traps in study area 1B in Yucca Flat, whereas no specimens of *inconspicua* were taken from those traps.

The type specimen of this species cannot be identified correctly in the most recent key to species of *Odontophotopsis* because Schuster (1958:57) indicates in couplet 4 that *obliqua* has the "Head subtruncate behind, somewhat transversely rectangular, not evenly, suddenly narrowed behind eyes, the short temples not inflated. . . ." The head of the holotype is definitely not subtruncate behind nor somewhat transversely rectangular. When the head outline was drawn on graph paper by means of an ocular grid, it coincided perfectly with an arc drawn with a compass. Consequently, the holotype better fits the alternative in couplet 4: "Head evenly semicircular in dorsal outline, behind the eyes, the temples not at all developed. . . ." The holotype does not fit the descriptions of any of the taxa which key from this alternative, however.

Odontophotopsis obliqua has mandibles, clypeus, mesosternal tubercles, and felt lines very much like other members of Schuster's *mellicausa* complex, but it has several distinguishing characteristics. The pygidium usually appears dull, as though greasy, and has more or less distinct punctures on approximately the apical one-third. Sometimes a weak pygidial fringe emanates from the more apical of these punctures. Furthermore, the marginal cell is approximately one-third longer than the stigma. This differentiates *obliqua* from some, but not all of the *mellicausa* complex.

Examination of the holotype and specimens on loan and in my personal collection indicates that *obliqua* occurs as far north as Vernon, British Columbia, Canada, into the Columbia and Snake River Valleys, throughout the valleys of the Great Basin Desert, the valleys and foothills of California, and south into Baja Cali-

fornia. Although at the test site this species occurs in the Mojave Desert portion, further collections and studies will be required to determine its distribution in the Mojave and Sonoran Deserts.

Odontophotopsis (Odontophotopsis) quadrispinosa Schuster

Odontophotopsis (Odontophotopsis) quadrispinosa Schuster, 1958. Entomol. Amer., 37(n.s.): 51.

Type data. Holotype ♂ Baja California (apparently in the Schuster collection). Paratype ♂ locality unknown to me (UM).

Discussion. Thirty-three specimens of *quadrispinosa* were attracted to incandescent and ultraviolet lights in the environs of Mercury, the west side of Frenchman Flat, at the base of Rainier Mesa in a stand of *Coleogyne ramosissima*, and in the *Pinus monophylla* and *Artemisia tridentata* on the top of Rainier Mesa. One specimen was caught in a box-type mammal trap on the ridge between Frenchman and Yucca Flats, and another was taken from a Berlese funnel in which the roots and root crown of *Coleogyne ramosissima* had been placed for extraction of arthropods. Evidently the mutillid had been hiding during the day in abandoned insect burrows in the plant.

The distribution of *quadrispinosa* has been unknown since only the vague type locality "Baja California, Mexico" was cited by Schuster. Specimens in my collection were taken at the following localities: 1 mi NW Nixon, Washoe Co., Nevada; 6 mi S Palm Springs, Riverside Co., California; and 12 mi N Earp, San Bernardino Co., California. These records, those from the test site, and the type locality suggest that this species of small size may have as great an altitudinal distribution as any of our nocturnal Mutillidae. Furthermore, on the basis of these distributional data, one can expect a much wider distribution than is presently known.

Identification of this species is based on brief examination of a specimen of *quadrispinosa* obtained from Schuster in July, 1959. I believe that the specimen described in Schuster's key, which validates the name *quadrispinosa*, is abnormal in having small wing cells. None of the specimens which I recognize as *quadrispinosa* has such venation. These have the general facies of *Sphaeropthalma (Micromutilla) difficilis*, but have the very obscure mesosternal tubercles about four times farther apart than the tubercles are long. The genitalia are somewhat like those of *difficilis* in having the parameres the same shape, but they lack the mesally directed long hairs at midlength. The cuspis also is about two-thirds the length of the parameres, but has the mesally directed hairs short, and lacks the slight enlargement at the apex.

Odontophotopsis (Odontophotopsis) serca Viereck

Odontophotopsis sercus Viereck, 1904. Trans. Amer. Entomol. Soc., 20:87.

Type data. Holotype ♂ Lower California, Mexico (ANSP type no. 4979).

Discussion. Fifteen specimens were collected at incandescent light on the hillsides above Mercury, and one was found in a box-type trap used for collecting mammals. Apparently this species does not occupy the lower portions of the test site, and it does not exist in the Great Basin portion. A small number of additional specimens in my collection indicate that *serca* has a continuous distribution from the test site through the Mojave and Colorado Deserts into Lower California.

Identification of these specimens is based on examination of the holotype and comparison of the test site series with the other specimens mentioned above. There is enough variability in the mediobasal portion of the clypeus to occasionally make it difficult to distinguish members of this species from those of *armata*. There is a tendency toward development of a slight secondary mesosternal tubercle on the mesal side of the primary one. Sometimes this is unilateral. Apparently the area where a sternal felt line should be never develops excess plumose hairs in the absence of micropunctures, as sometimes happens in occasional specimens of *armata*.

Odontophotopsis (Odontophotopsis) setifera Schuster

Odontophotopsis (Odontophotopsis) setifera Schuster, 1952. Bull. Brooklyn Entomol. Soc., 47(2):47.

Type data. Holotype ♂ Palms to Pines Highway, Riverside Co., California, 1000 ft elevation (RMS). Paratype ♂ Ehrenberg, Arizona (UM).

Discussion. One specimen was collected at the test site in study site 5E on July 27, 1960. This section of Frenchman Flat is within the Larrea-Franseria community (Allred, *et al.*, 1963a:Fig. 44), although vegetation at the spe-

cific collection site of this specimen is predominantly *Lycium pallidum*.

Two specimens in the San Jose State College collection are from nearby Death Valley, and provide additional information concerning the occurrence of *setifera* as indicated by the label data: Stovepipe Wells, Death Valley, California; May 31, 1952. In spite of intensive collecting of nocturnal Mutillidae in recent years in the arid western states, *setifera* appears to be rare, and apparently does not occur in the Great Basin Desert. Hence, it probably is near the northern limits of its range in Frenchman Flat (3080 ft) and at Stovepipe Wells (sea level), and probably does not occur even in the lower parts of Yucca Flat (3914 ft).

Odontophotopsis (Periphotopsis) mamata Schuster

Odontophotopsis (Periphotopsis) mamata Schuster, 1958. Entomol. Amer., 37(n.s.):60.

Type data. Holotype ♂ Arizona (UM). Paratypes: Globe, San Carlos, and Roosevelt Lake, Gila Co.; Phoenix, Maricopa Co.; Tucson, Pima Co., Arizona; Rosamond, Kern Co.; Mecca, Palm Springs, and Pinon Flats, Riverside Co., California (UM).

One hundred specimens were collected at the test site, making *mamata* one of the three most abundant species known only from the male sex. It occurred most abundantly in the *Atriplex* and *Larrea* associations at study areas 5A and 5E, respectively. It was caught there regularly in can traps in July and August, and at incandescent and ultraviolet light-traps during intensive collecting in August, 1964. At the Command Post (CP) study site, on the ridge between Frenchman Flat and Yucca Flat, twelve were collected from box-type Allred mammal traps on August 28, 1959, but at no other time. Eight came from one trap (CPA3L) and four from another (CP1L). The unusual concentration of males in one trap suggests that they might have been lured in by the odor of a virgin female. However, no females were recorded from either trap on that date. One specimen was taken from can traps in study area 1B, in Yucca Valley. Additional light trap collections were made in the vicinity of Cane Springs, the hillside above Mercury, and in Jackass Valley.

The distribution of *mamata* at the test site confirms unpublished label data from my collection which indicate that it is not a Great Basin Desert species. Rather, it is common in the Mojave and Sonoran Deserts.

Dasymutilla gloriosa (Saussure)

Mutilla gloriosa Saussure, 1867. Ann. Soc. Entomol. France, (Ser. 4) 7:359.

Mutilla tecta Cresson, 1875. Trans. Amer. Entomol. Soc., 5:119.

Dasymutilla reperticia Mickel, 1928. Bull. U.S. Nat. Mus., 143:287.

Type data. *Mutilla gloriosa* ♀ and *D. reperticia* ♂, refer to Mickel (1928:242, 288). *Mutilla tecta*, type ♀ California (ANSP).

Discussion. Only three females of this distinctive species were collected at the test site in July, August, and September. One specimen came from a can pit-trap at Cane Springs, a second was taken by hand in Jackass Flats, and the third from an unknown locality.

The distribution of *gloriosa* is well documented, and indicates that its range is rather closely coincident with that of the creosote bush, *Larrea divaricata*. Since the northern limit of *Larrea* is at the test site and *gloriosa* is rare there, it likely will not be found in the Great Basin Desert portion of the test site.

Dasymutilla paenulata Mickel

Dasymutilla paenulata Mickel, 1928. Bull. U.S. Nat. Mus., 143:206.

Type data. Holotype ♀ Phoenix, Arizona (CU type no. 764.1). Paratype ♀ Phoenix, Arizona.

Discussion. One specimen of this apparently rare species was found in a can pit-trap at locality TA, 4.4 mi S Tippipah Spring, in July. The specific vegetation there is *Artemisia tridentata*, although Allred, *et al.* (1963b) consider the general area to be part of the Coleogyne community. Little can be said about the occurrence of *paenulata* at the test site as it relates to the distribution of the species, because this is only the third specimen recorded in the literature.

Identification was made by means of the key and description by Mickel (1928, 1936) without examination of type material.

Dasymutilla satanas Mickel

Dasymutilla satanas Mickel, 1928. Bull. U.S. Nat. Mus., 143:239. ♀.

Dasymutilla mimula Mickel, 1928. Bull. U.S. Nat. Mus., 143:255. ♂.

Type data. Refer to Mickel (1928).

Discussion. Twenty-four females were collected from Jackass, Frenchman, and Yucca Flats from early July to late September. All except two were found in can pit-traps. One of these two was picked up on the desert by hand, but the other apparently was attracted by ultraviolet light and fell into a water trap on the ground (Fig. 3).

Only one male *satanas* was collected during the entire study, at locality 5A in Frenchman Flat, on July 6. The method of capture was not recorded.

The distribution of *D. satanas* extends from deep in the Sonoran Desert of Baja California and Sonora, Mexico, apparently to about 4400 ft in the higher desert valleys such as Yucca Flat, along the northern margin of the Mojave Desert.

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